

Appendix I – Monroe Mountain Aspen Ecosystems Restoration Project Fire Ecology/Fire/Fuels Specialist Report (Chappell et al. 2015)



Prepared by:

Wess Freeborn
Fuels Specialist

Linda M. Chappell
Fire Ecologist

Scott Tobler
Fire Planner

Stanley G. Kitchen
Research Botanist

With thanks to: LaWen Hollingsworth, Fire Behavior Specialist, Missoula Fire Lab
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Fishlake National Forest
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Executive Summary

This report analyzes and evaluates if and how mechanical treatments and prescribed fire together would effectively return aspen ecosystems to a functioning condition now, and in the future. It also analyzes whether proposed treatments would move vegetation towards desired condition, meet the purpose and need, and evaluates potential impacts to private property.

This analysis focused on changes that would be expected by implementation of the various alternatives. Metrics used include:

1. Changes in aspen regeneration and recruitment
2. Changes to available fuels/fire behavior through changes to flame length, crown versus surface fire and spotting
3. Acres treated

These changes are important as they not only measure how well the action would achieve the purpose and need, through increasing resilience to undesirable large-scale disturbance and are important in determining any adverse effects to private lands adjacent to the proposed treatment areas. The magnitude of the changes combined with existing, past, present and reasonably foreseeable actions resulted in aspen regeneration and recruitment on about 36,300 acres change from existing conditions.

The Monroe Mountain Aspen Ecosystems Restoration Project will not dictate any response to wildfires. However, action alternatives should increase the decision space for Agency Administrators deciding how to manage lightning caused fires, while reducing the potential for undesirable fire behavior and effects.

Alternative 4 treats the most acres mechanically, lowering the risk of undesirable fire behavior for prescribed fire in the short term, and uncharacteristic wildfire risk in the long term. Fuels would be reduced in a mosaic pattern, decreasing the risk of larger, more severe fires. This increases the likelihood that fire would return to a more resilient role in the long term, moving aspen ecosystems toward the desired condition.

The no action alternative would result in continued movement away from desired aspen vegetative conditions. Desired conditions would not be achieved in the foreseeable future. The few functioning aspen/mixed conifer ecosystems would be irretrievably lost due to lack of disturbance, continued conifer growth and continued ungulate overbrowsing of the few aspen suckers attempting to regenerate and recruit.

Additionally, private inholdings would be at more risk of larger and more severe wildfires as a result of deferring the proposed aspen restoration. Firefighters responding to the inevitable wildfires would also be at greater risk due to untreated fuels exhibiting more extreme fire behavior than treated fuels would.

Introduction

Monroe Mountain, located in south-central Utah, south of Richfield, west of Koosharem, and east of Marysvale, encompasses approximately 175,706 acres of National Forest lands administered by the Fishlake National Forest, Richfield Ranger District, and approximately 11,805 acres of private inholdings (Figure 1).



Of these 175,706 acres, quaking aspen (*Populus tremuloides*) historically occurred on approximately 71,000 acres on Monroe Mountain (Figure 2). Soil survey information was used to estimate the historic occurrence of aspen. It is widely recognized that aspen ecosystems are capable of supporting one of the largest arrays of plant and animal species due to its high productivity and structural diversity. However, it is also widely recognized that aspen ecosystems have been in decline throughout the Intermountain West during the twentieth century (UFRWG 2010).

On Monroe Mountain, unsustainable aspen ecosystem conditions include, but are not limited to,

1. Conifer encroachment due to a reduced occurrence of wildland fire because of an increase in wildland fire suppression; and,
2. Lack of aspen recruitment due to domestic and wild browsing by cattle, sheep, elk, and deer.

Reduced occurrences of wildland fire due to an increase in wildland fire suppression, and overbrowsing by domestic and wild browsers have been identified by the District as the primary underlying causes for aspen ecosystems on Monroe Mountain being at risk. Aspen of 5 to 15 feet in height (“recruitment”) are uncommon on Monroe Mountain, despite continued sprouting of aspen (“regeneration”). Due to high cost and continual maintenance, fencing is not a long-term sustainable response option for protecting aspen sprouts from overbrowsing, and does not address underlying causes of the lack of recruitment.

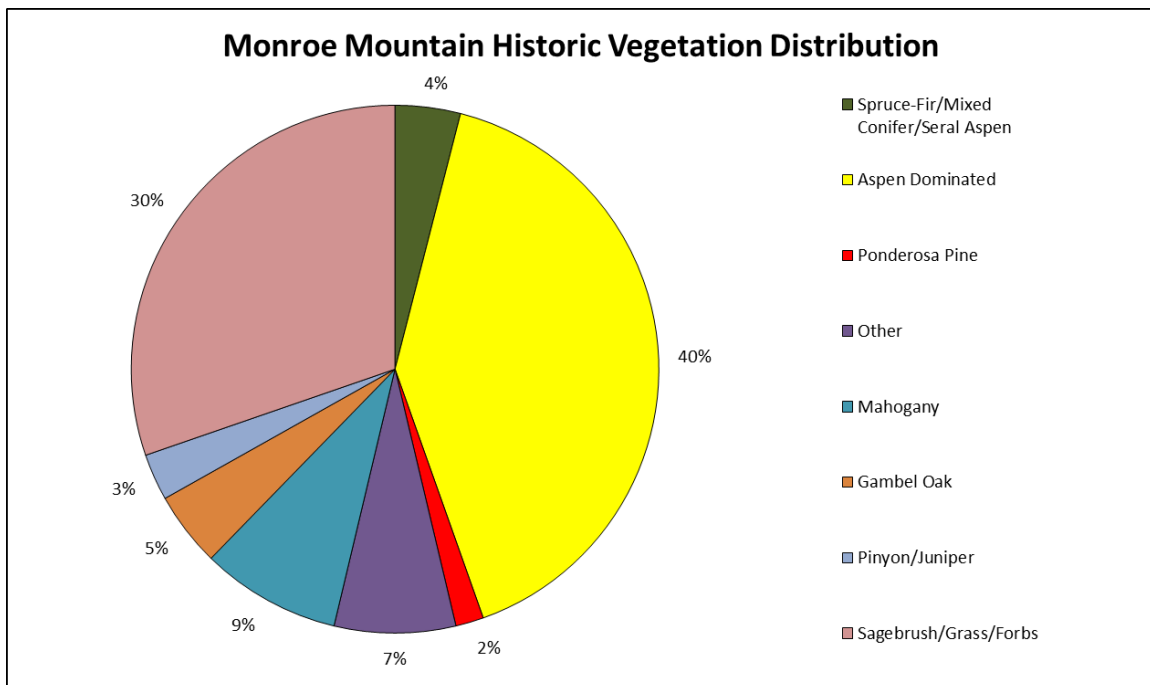


Figure 2: Monroe Mountain Historic (200 to 400 Years Ago) Dominant Vegetation Distribution

Aspen is a keystone species and historically was a landscape dominant on Monroe Mountain. Aspen ecosystems support the highest level of biodiversity for interior

western forests and the productivity of aspen ecosystem understories (grass, forbs, and shrubs) is higher than all other forest types. Individual aspen trees arise almost exclusively from root suckers and are relatively short-lived (i.e., 100 to 200 years). Aspen is shade intolerant and sprouts heavily following disturbance, such as fire, and benefits from disturbance especially where conifer currently shades and competes with aspen. Mechanical treatments can also be an effective disturbance tool for aspen restoration.

Aspen-mixed conifer communities on Monroe Mountain developed with fire as a historical disturbance process. Published multi-century fire histories for Monroe Mountain and five regional landscapes with similar topography and vegetation reveal patterns of abundant fire prior to Euro-American settlement in the mid to late-1800s (Heyerdahl et al. 2011). For four sites, stand demographics, surface fire frequency, and fire severity were characterized for plots arranged in grids to represent a broad range in elevation and vegetation type within small watersheds. Aspen was found in 62 percent (59 of 95) of the study plots. Of these, 53 percent were classified in low to mixed severity fire classes with short to moderate fire-free intervals while the remaining plots were classified as having high fire severity and assumed longer intervals. Fire-scarred ponderosa pine trees (*Pinus ponderosa*) sampled on Old Woman Plateau revealed a consistent pattern of frequent surface fire from the 1500s to the late 1800s. This site is located approximately 40 miles northeast of Monroe Mountain and like much of the east-central and southern portions of Monroe Mountain is characterized by gentle terrain with small stands of aspen separated by openings of mostly non-forested sagebrush steppe.

Reported fire evidence from Monroe Mountain was limited to 10 fire-scarred ponderosa pine trees sampled from across a large portion of the mountain. Although ponderosa pine is an excellent species for preserving long records of surface fire, it is an uncommon species on Monroe Mountain and as such is not sufficiently abundant to drive fuels and fire dynamics. However, the short to moderate fire frequency evident from the sampled trees (Figure 3) is supported by widespread evidence of past fire in the form of fire-injured Douglas fir (*Pseudotsuga menziesii*) and Engelmann spruce trees (*Picea engelmannii*; including multiple injuries per tree; (Figure 4) and charred remnants. Collectively, this site-specific evidence and data from the intensively sampled regional sites support an interpretation of historic fire-regimes that included a range of short to long fire-free intervals and low to high fire severity, creating and maintaining a diverse and dynamic vegetation mosaic across time and space. These spatially complex fire regimes ended within decades of Euro-American settlement. As a result, diversity was lost as forest communities became dominated by late seral¹ conditions. In mixed stands, aspen cover and viability decreased due to the lack of disturbance over the past 150 plus years. Although persistent or stable² aspen (little or no conifer present) may not be dependent upon periodic fire for regeneration, the evidence suggests that fire was sufficiently abundant across these montane landscapes such that even these conifer-free aspen communities were likely exposed to fire periodically.

¹ A seral aspen community may have some aspen in the overstory, but mostly it is a community where conifer is becoming the dominant species.

² A stable aspen community has a predominantly aspen overstory with little to no conifer regeneration.

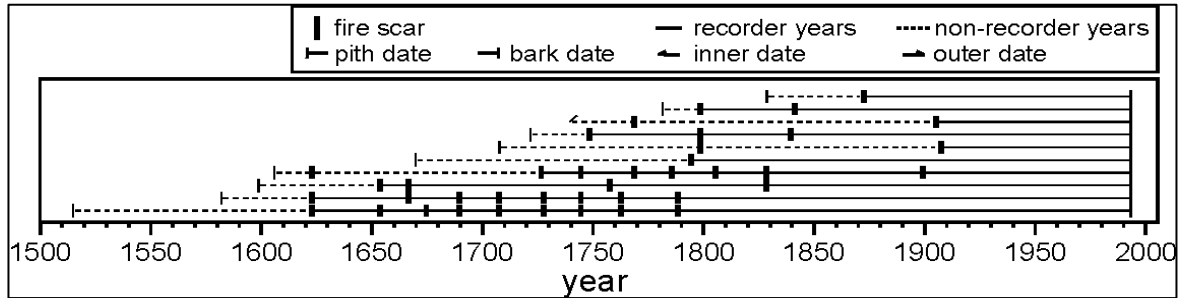


Figure 3: Chronologies of surface fires at Monroe Mountain, sampled over an approximately 35-mile north south transect. Each horizontal line indicates the length of record for a single tree. The short vertical lines indicate years when that tree had a fire scar. Recorder years (solid lines) generally follow the first scar on each tree. Non-recorder years (dashed lines) precede the formation of the first scar on each tree, but also occur when a period of the fire record was consumed by subsequent fires or decay. Inner and outer dates are the dates of the earliest or latest rings sampled for trees where pith or bark was not sampled (Heyerdahl et al. 2011).



Figure 4: Fire-scarred Engelmann spruce, with evidence of three separate fires near Monkey Flat Ridge, Monroe Mountain (photo credit Stan Kitchen).

Ecosystem Management on Monroe Mountain

The Fishlake National Forest is uniquely suited to apply ecosystem management principles on the Monroe Mountain watersheds. There are large amounts of published research contributing to local knowledge of the resources interacting on the mountain. The information includes fire history studies, soils characteristics studies, elk and deer use studies, aspen studies, rangeland use, etc. These have been ongoing over the last decades and provide strong support, background and perspective on what is possible in these important watersheds.

“With an emphasis on sustaining ecosystems, resource managers must evaluate activities in the context of sustaining natural ecosystem features. Fire suppression and other activities have changed ecosystems dramatically. Therefore, considerable vegetation management activities, such as prescribed fire, may be desirable to restore the effects of both catastrophic and low-severity fires to create conditions that favor species relying on past disturbance regimes in the landscape. Tree removal may be desirable to restore stand structure and composition to levels expected from natural disturbances.” (Kaufmann, et. al. 1994).

The difficulties of using fire on a landscape scale include narrow burn windows, private inholdings, human infrastructure, possible smoke impacts, and acres of forests too overgrown to manage with fire alone have sometimes led to mechanical treatments being used in place of fire. Mechanical treatments can be an effective disturbance tool for aspen restoration, although the effects to ecosystems are not the same as fire effects.

In an interview with the National Fire Protection Association in 2011, noted Fire Historian Stephen Pyne summarized it well, “Fire has a lot of other ecological effects besides consuming surplus fuel. It’s a biochemical reaction-it releases nutrients and it rearranges things. That’s why fire and logging are not equivalent operations. Logging takes the big stuff and leaves the little. Fire burns the little and leaves the big. One doesn’t substitute for the other. It’s the whole sense that these landscapes are now out of sync...” (Pyne, S. 2011). The Fishlake National Forest is striving to enhance restore the structure, function and composition of aspen ecosystems on Monroe Mountain so that they are fully functioning disturbance based ecosystems.

Laws, Regulations, and Policy affecting Fire Ecology, Fire, and Fuels

National Level Direction

Federal laws, regulations, and policies affecting this project include:

- Organic Administration Act, June 4, 1897 (16 U. S. C. 551): This act authorizes the Secretary of Agriculture to make provisions for the protection of national forests against destruction by fire. Treatments proposed by this project would support the intent of the Organic Administration Act by reducing the potential for undesirable fire behavior and effects.
- National Environmental Policy Act of 1970. Compliance with this act requires analysis of proposed actions, including prescribed fire, so an analysis of the effects of prescribed fire as well as the resulting emissions are included as part of the documents.

The “1995 Federal Wildland Fire Policy” is the principle document guiding fire management on Federal lands. The Policy was endorsed and implemented in 1995. The 1995 Federal Wildland Fire Policy was reviewed and updated in 2001 (Review and Update of the 1995 Federal Wildland Fire Management Policy, 2001). In 2003 the Interagency Strategy for the Implementation of Federal Wildland Fire Management Policy was approved. The 2003 Implementation Strategy was replaced in 2009 with the adoption of the Guidance for Implementation of Federal Wildland Fire Management Policy which states that:

“Fire, as a critical natural process, will be integrated into land and resource management plans and activities on a landscape scale, and across agency boundaries. Response to wildland fire is based on ecological, social, and legal consequences of fire. The circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources, and values to be protected dictate the appropriate management response to fire.”

The Monroe Mountain Aspen Ecosystems Restoration Project will not dictate any response to wildfires. However, action alternatives should increase the decision space for Agency Administrators deciding how to manage lightning caused fires, while reducing the potential for undesirable fire behavior and effects. The effects of planned ignitions (prescribed fires) are discussed. This document provides direction, consistent with the Fishlake National Forest Land and Resource Management Plan regarding the use of planned ignitions in the proposed treatment area.

The 2009 Guidance for Implementation of Federal Wildland Fire Management Policy (NWCG 2009) provides the terminology related to fire used in this report. ‘Wildland fire’ is a general term describing any non-structural wildland fires, categorized in two distinct types:

- **Unplanned ignitions (wildfire).** Wildfires are unplanned ignitions, including escaped prescribed fires that are declared wildfires. Wildfires may be ignited by natural causes, namely lightning, or human caused (NWCG 2009).
- **Planned ignitions (prescribed fire).** Planned ignitions are fires initiated by the intentional initiation of a wildland fire by hand-held, mechanical or aerial device where the distance and timing between ignition lines or points and the sequence of igniting them is determined by environmental conditions (weather, fuel, topography), firing technique, and other factors which influence fire behavior and fire effects (NWCG 2009). “Prescribed fire” includes pile burning, jackpot burning, broadcast burns or other wildland fires originating from planned ignitions to meet specific objectives identified in a written, approved, prescribed fire plan for which NEPA requirements (where applicable) have been met prior to ignition (NWCG 2009, FSM 5100).

Agency Level Direction

USDA Forest Service

Forest Service Manual 5100 (page 9) includes direction on USFS use of prescribed fire to meet land and resource management goals and objectives. The objectives of fire management on lands managed by the USFS are:

1. Forest Service fire management activities shall always put human life as the single, overriding priority.
2. Forest Service fire management activities should result in safe, cost-effective fire management programs that protect, maintain, and enhance National Forest System lands, adjacent lands, and lands protected by the Forest Service under cooperative agreement.

New: 5103.1 - Risk Management and Risk Reduction

1. Firefighter and public safety is the first priority in every fire management activity. The wildland fire management environment is complex and possesses inherent hazards that can---even with reasonable mitigation---result in harm. In recognition of this fact, we are committed to the aggressive management of risk.

5103.2 - Ecological

1. Identify and use fire ecology to frame land and resource management objectives.

2. Use Fire Management programs and activities to implement Land and Resource Management Plans (L/RMP) objectives.
3. Incorporate public health and environmental quality considerations into fire management programs and activities.
4. Manage the land to make it more resilient to disturbance, in accordance with management objectives.

Again, new: Forest Service Manual 5140 (page 8) includes direction on USFS use of prescribed fire to meet land and resource management goals and objectives.

5140.2 - Objectives

1. Understand the role of fire on the landscape in order to integrate fire, as a critical natural process, into land and resource management plans, and develop achievable and sustainable Land and Resource Management Plan (LRMP) objectives that provide for landscapes which are resilient to fire related disturbances and climate change.
2. In cooperation with partners, strategically plan and implement on a landscape scale, risk-informed, and cost-effective hazardous fuel modification and vegetation management treatments (wildland fire (wildfire and prescribed), mechanical manipulation, biological, and chemical) to attain management objectives identified in Land and Resource Management Plans, to protect, sustain, and enhance resources and, where appropriate, emulate the ecological role of natural fire.

5142 - PRESCRIBED FIRE

5142.3 - Policy

1. When appropriate, use prescribed fire in a safe, carefully planned, and cost-effective manner to achieve desired conditions and attain management objectives identified in Land and Resource Management Plans (FSM 1920).
2. The NWCG Interagency Prescribed Fire Planning and Implementation Procedures Guide - PMS 484, is Forest Service policy (incorporated by reference at: <http://www.nwcg.gov/pms/RxFire/rxfireguide.pdf>). (FSM 5142, Page 8)

Fishlake National Forest Land and Resource Management Plan

This action responds to the goals and objectives outlined in the Fishlake Land and Resource Management Plan (LRMP) (1986) as amended. The desired conditions described below and in the Monroe Mountain Aspen Ecosystems Restoration Project Environmental Impact Statement (EIS) and the purpose and need for this project are consistent with the Forest's goals, the objectives found in Chapter IV of the LRMP, and the Utah Fire Amendment (USFS 2001). The proposed treatment units are within

management areas 2B – Rural and Roaded Natural Recreation; 4A – Fish Habitat Improvement; 4B – Habitat for Management Indicator Species; 5A – Big Game Winter Range - Non-forested; 6B – Intensive Livestock Management; 7B – Wood-Fiber Production - Genetics; and 9F – Improved Watershed. The relevant goals and objectives are listed below:

1. Ecosystems are restored and maintained, consistent with land uses and historic fire regimes, through wildland fire use and prescribed fire (Utah Fire Amendment, pg. A-40).
2. Manage forest cover types to provide variety in stand sizes shape, crown closure, edge contrast, age structure and interspersed (LRMP p. IV-99).
3. Prescribed fire is authorized forest-wide (Utah Fire Amendment, pg. A-41).
4. Use prescribed fire to reduce fuel buildup and meet resource objectives (LRMP p. IV-5).
5. Reduce hazardous fuels; the full range of reduction methods is authorized, consistent with forest and MA emphasis and direction (Utah Fire Amendment, pg. A-41).
6. Identify and improve habitat for sensitive, threatened, and endangered species including participation in recovery efforts for both plants and animals (LRMP IV-4).
7. Improve or maintain the quality of habitat on big game winter ranges (LRMP IV-4).
8. Maintain structural diversity of vegetation on management areas dominated by forested ecosystems (LRMP IV-11).
9. Manage aspen for retention where needed for wildlife, watershed, or esthetic purposes (LRMP IV-11).
10. Manage seral aspen stands for a diversity of age classes (LRMP IV-11).
11. Manage aspen to perpetuate the species and improve quality (LRMP IV-4).
12. Provide wood fiber while maintaining or improving other resource values LRMP IV-4).
13. Improve timber age class distribution and maintain species diversity (LRMP IV-4).
14. Manage tree stands using both commercial and noncommercial methods. Enhance visual quality, diversity, and insect and disease control (LRMP IV-62 and IV-84d).
15. Maintain and manage forested inclusions to provide a high level of forage production, wildlife habitat, and diversity (LRMP IV-112).
16. The area will have a mosaic of fully stocked stands that follow natural patterns and avoid straight lines and geometric shapes (LRMP IV-113).
17. Prevent and control insect infestation and disease (LRMP IV-5)

One goal of this project is to move toward historic fire regimes in these vegetation types on Monroe Mountain. Wildland fire is authorized forest-wide by the Utah Fire Amendment (A-41) under management area goal IV-3 (Diversity), except in the following areas:

1. Administrative sites;
2. Developed recreation sites;
3. Summer home sites;
4. Designated communication sites;
5. Oil and gas facilities;
6. Mining facilities;
7. Above-ground utility corridors; and,
8. High-use travel corridors.

The management response for these locations will be wildland fire suppression if they are threatened. In areas authorized for wildland fire use, the full range of management responses (from full suppression to monitoring of wildland fire activity) may be used. The goal is to “ultimately increase the probability that future naturally caused fires can be managed (if possible, not suppressed) to move toward natural processes in these disturbance dependent aspen ecosystems on Monroe Mountain.”

Purpose and Need

The purpose of this project is to restore aspen ecosystems on Monroe Mountain by achieving the desired conditions. To help accomplish this purpose, the District has identified a need to (1) address the conifer encroachment that occurs due to the reduced occurrence of wildland fire because of an increase in wildland fire suppression, and (2) address aspen overbrowsing by domestic and wild ungulates. These are two of the primary underlying causes for aspen decline on Monroe Mountain. Restoring aspen communities on Monroe Mountain will result in multiple benefits, which include but are not limited to:

1. Improving and increasing the amount of habitat for wildlife species dependent upon aspen ecosystems (i.e., mule deer, elk, and Northern goshawk);
2. Improving and increasing the amount of habitat and forage for domestic ungulates (i.e., cattle and sheep);
3. Improving native species diversity;
4. Reducing hazardous fuel accumulations;
5. Reducing the risk of large-scale, intense wildland fires. This results in lower risk to the safety of the public and firefighters. This also results in lower risk to sensitive wildlife species (i.e. Northern goshawk, Western Boreal toad (*Bufo boreas*), and Bonneville cutthroat trout (*Oncorhynchus clarki utah*)); and,
6. Increasing the probability that future naturally caused fires can be managed (if possible, not suppressed) and allowed to play the greatest feasible natural role in the aspen ecosystems on Monroe Mountain (Utah Fire Plan 2001).

A number of issues were identified by the interdisciplinary team and cooperators. Only one was a fire/fuels related issue.

Issue 2 – Prescribed fire activities may impact adjacent private property

Prescribed fire activities may result in impacts to private property. Current fuel loads in areas adjacent to private properties generally do not allow prescribed fire activities to be managed safely with low risk of affecting private property. The reduced occurrence of wildland fire due to an increase in wildland fire suppression has contributed to the increased fuel loads over most of Monroe Mountain, including areas adjacent to private property.

Indicator: changing fuel loads adjacent to private lands, via mechanical treatments, to facilitate safer prescribed fire burn conditions. These will include flame length, spotting and crown versus surface fire.

Methodology for Analysis

The method of analysis is primarily fire behavior modeling to predict the behavior of a fire in the project area for the vegetation conditions that would exist under the No-action and range of proposed alternatives. Fire behavior model inputs were obtained from a combination of historical weather records and the weather prescription used during implementation of the Box Creek broadcast prescribed fire in late spring of 2012. Forest Vegetation Simulator outputs from stand exam data were used to inform fuel model and canopy characteristics choices.

The landscapes were developed utilizing Landfire 2010 vegetation cover. Fuel models were identified by a small group of fire specialists, then reviewed and approved by a fire modelling expert at the Missoula Fire Lab. These fuel models are based on the current and expected post treatment vegetation types. A side-by-side comparison of the modeling results shows how the alternatives would alter fire behavior. Below is a list of outputs that were evaluated.

- Flame Length (FL)
- Spotting Distance
- Crown/Surface Fire Activity

For more information on how the fire models work, please see Appendix FM.

These models were developed to predict wildfire behavior for fire behavior analysts, often working on specific landscapes. We are pushing the models' capabilities in attempting to determine post-treatment fire effects (Ager, 2011).

Since it can be difficult to demonstrate differences among alternatives using just a single fire behavior indicator, such as flame length or spotting, an index combining the flame length, spotting distance and crown/surface fire activity outputs was created. This index displays combined fire behavior differences among the no action and action alternatives proposed in this project.

The issue of fire impacting private lands necessitated a focus on fire behavior in and adjacent to the mechanical treatments beside the private lands, both after the mechanical

treatments occur and once the project is completed. A distance filter from private land boundaries was applied to differentiate among the four action alternatives when compared to the no action alternative.

Specific burn parameters will be addressed at the burn plan level for project implementation. Each burn unit will have site specific burn prescriptions developed to successfully implement both the pile burning and the prescribed burning once the mechanical and pile burning is completed. These parameters include items such as fuel model, fuel loading and moisture, weather, organization and equipment needed, a communication plan, safety and medical plan to meet objectives (Interagency Burn Plan Template, 2014). Each burn plan requires line officer approval to implement.

Timeframes and Spatial Boundaries

Treatment priorities are primarily based on the current distribution of wild browsers on Monroe Mountain. The first priority for mechanical and prescribed fire treatments would be in the southerly portion of the project area (Area 1; Figure 5) where visually, current browse pressures on aspen appear to be less than the northerly and central portions of the project area. A secondary priority would be the northerly portion of the project (Area 2; Figure 5). Browse pressures in the north appear to be higher than what is occurring in the south, but less than the central portion of the project area. Treatments in the central portion of the project area would be the third priority (Area 3; Figure 5). By prioritizing the project in this order, browse pressure may be more directed away from newly treated areas; this is expected to increase the probability of recruiting aspen to reach 6 feet tall after treatment.

Mechanical treatments are proposed in areas adjacent to private lands, and within/adjacent to Northern goshawk, boreal toad, and Bonneville cutthroat trout habitat. These aspen, spruce/fir, and mixed conifer areas would be the highest priority for treating as soon as possible within each area (Areas 1, 2, and 3). Implementing these mechanical treatments first would help reduce the risk of impacts from prescribed fire to private property, Northern goshawk, boreal toad, and Bonneville cutthroat trout.

The issue of fire impacting private lands necessitated a focus on fire behavior in and adjacent to the mechanical treatments beside the private lands. A mile wide distance filter was applied to differentiate among the four action alternatives when compared to the no action alternative. A mile was selected as the majority of the embers created by prescribed fire in the modelling moved a mile or less before landing on available fuel. Lower flame lengths within a mile of private lands are less likely to create embers that could reach and ignite fires on the private lands. Lower flame lengths create a safer situation to ignite prescribed fires while also reducing the risks of embers starting a fire(s) on the private lands. Flame lengths drive the production of embers, and is thus important in determining the likelihood of an ember starting an unwanted ignition on private lands.

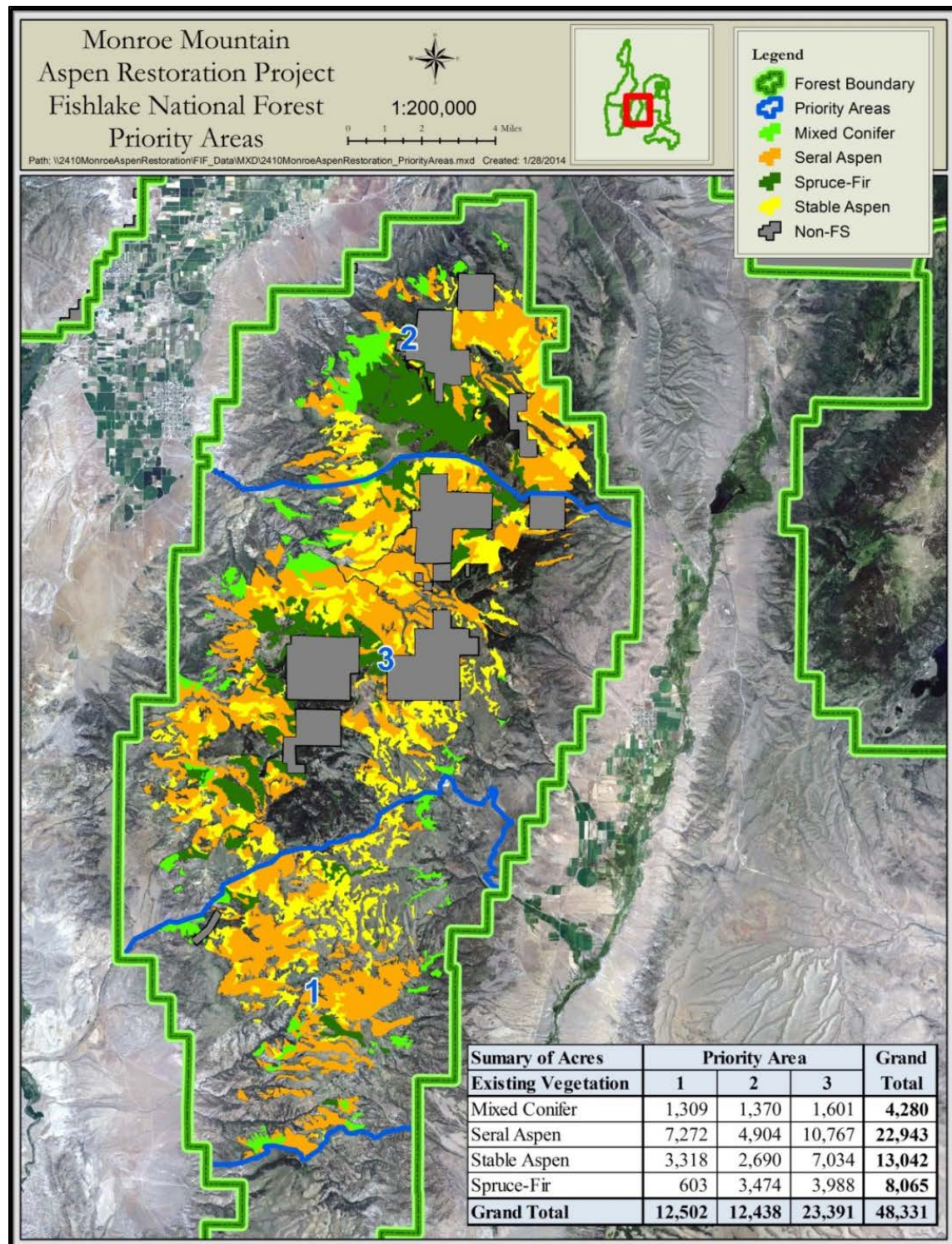


Figure 5: Current Dominant Vegetation and Treatment Area Priorities

Environmental Indicators

The environmental indicators listed below were selected by a sub-group of fire/fuels/modeling specialists. These indicators were determined to be the critical indicators that are relevant for decision making.

- Firefighter and Public Safety
- Flame Length (FL)
- Spotting Distance
- Crown/Surface Fire Activity

Firefighter and public safety are assessed through changes in fuels and therefore fire behavior shown in the fire modeling. Existing condition is modeled and then examined in the context of the Alternatives One through Five.

Flame lengths are one such indicator of safety:

Flame Length (Feet)	Interpretation
<4	Fire can generally be attacked at the head or flanks by persons using handtools.
4-8	Fires are too intense for direct attack on the head by persons using handtools. Handline should hold the fire.
8-11	Fires may present serious control problems – torching out, crowning, and spotting. Control efforts at the fire head will probably be ineffective.
>11	Crowning, spotting, and major fire runs are probable. Control efforts at head of fire are ineffective.

Table 1: Fire suppression interpretations of flame length compared to safety. Andrews and Rothermel, 1982.

A fire behavior characteristics chart illustrates a primary characteristic of fire behavior: spread rate (Figure 6). The chart represents the character of a fire, which can range from a fast or slow spreading fire with low flame lengths, to a fast or slow spreading fire with high flame lengths. It helps communicate and interpret modeled or observed fire behavior. ‘Perhaps the single most valid characteristic of a fire’s general behavior and direct impact on above ground vegetation is ‘fire intensity as described by Byram.’ Fireline intensity (Btu/ft/s] is the amount of heat released per second by a foot-wide slice of the flaming combustion zone (Alexander, 1982). This value has been directly related to flame length, an observable characteristic of fire behavior. Fireline intensity is indicative of the heat that would be experienced by a person working near the fire. Flame length and fireline intensity can be interpreted in terms of suppression capabilities as shown in Figure 6 (Andrews and Rothermel, 1982).

The curved lines on the fire behavior chart define the areas of interpretations shown in Table 1. The interpretations range from fires being easily controlled by hand crews, to fire on which equipment can be effective, to fires on which control effort at the head will be ineffective.

The surface fire characteristics chart includes curves for several flame length values as related to rate of spread and heat per unit area (Figure 6) with symbols for fire suppression interpretations ranging from fires that can be attacked by firefighters with hand tools to fires for which control efforts are ineffective (Andrews, et.al, 2011)

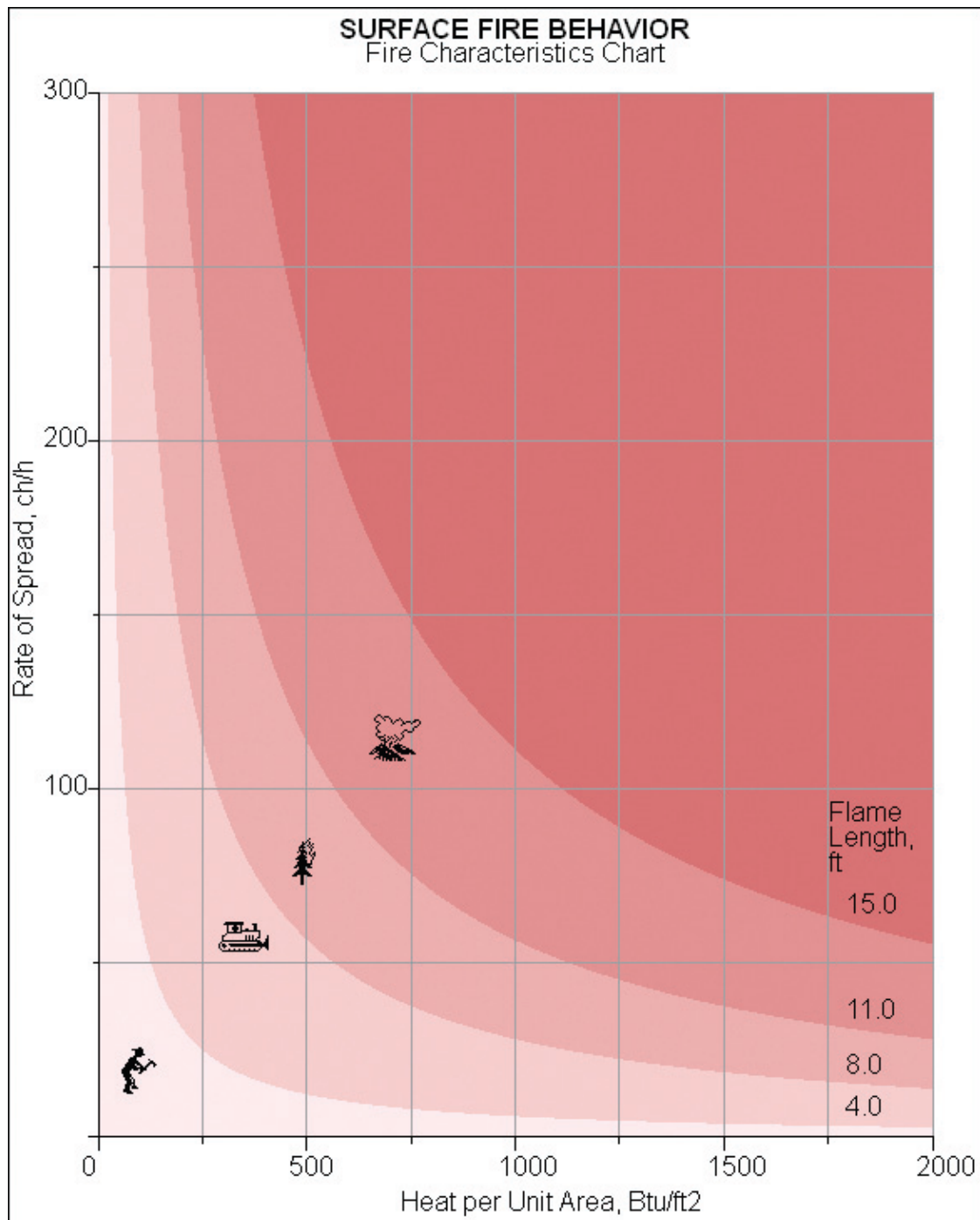


Figure 6: A fire behavior characteristics chart illustrates two primary characteristics of fire behavior – spread rate and intensity. Figures on the chart are an indication of fire suppression effectiveness related to flame length. (Andrews, et. al. 2011)

Indicators listed above are primarily short term indicators to address Issue 2; prescribed fire may impact private property.

The long term indicator chosen to show the health of aspen ecosystem is Properly Functioning Condition, utilizing the Region 4 process shown in Appendix PFC.

Properly Functioning Condition: Ecosystems at any temporal or spatial scale are in a properly functioning condition when they are dynamic and resilient to perturbations to structure, composition, and processes of their biological or physical components. The assessment utilized here was completed initially in 1998, as part of the then developed 'Prescribed Natural Fire Plan', updated in 2000 in the Fishlake National Forest Plan Amendment (Jackson, et.al, 1998).

Indicators are fire return interval and acres disturbed by ecosystem cover type.

Overview of the Proposed Action

Proposed Mechanical Treatments

Seral and Stable Aspen Stands

There are two mechanical treatment options being considered in this analysis for seral and stable aspen dominated stands (Photos 1 to 9; Appendix A):

1. Conifers would be removed and the existing aspen would be retained regardless of the size of the conifer or if it is located within an IRA or draft UUA. (Photos 2, 5, and 8; Appendix A; Table 2). To access the conifer, some incidental cutting of aspen may occur. This option would occur throughout the project area.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH and the existing aspen would be retained (Photos 3, 6 and 9; Appendix A; Table 3). In all areas outside the IRAs and draft UUAs, conifers would be removed and the existing aspen would be retained regardless of the size of the conifer.

Spruce/Fir and Mixed Conifer Stands – Proposed Mechanical Treatment Methods

There are also two mechanical treatments options being considered in this analysis for spruce/fir and mixed dominated conifer stands (Photos 10 thru 18; Appendix A):

1. This option would occur throughout the project area (Photos 11, 14, and 17; Appendix A; Table 2).
 - a. If present, beetle killed conifer trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (salvage harvest³).
 - b. If conifer trees are currently infected by beetles and are in the process of dying, the infected trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (sanitation harvest⁴).
 - c. In areas of spruce/fir or mixed conifer where LRMP stocking levels are below plan guidance due to bark beetle impacts, replanting of spruce or mixed conifer may occur. If the remaining live trees were greater than a BA of 90⁵, the remaining live trees would be thinned using uneven- aged management⁶ to a BA of 90 with single and group tree selection.
 - d. If no beetle killed or infested trees are present initially, trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH (Photos 12, 15, and 18; Appendix A; Table 3). In all areas outside the IRAs and draft UUAs, treatments would occur as in option 1 for spruce/fir and mixed conifer dominated stands.

³ Salvage harvest – The removal of dead trees, damaged trees, or dying trees resulting from injurious agents other than competition (Helms 1998).

⁴ Sanitation harvest – The removal of trees to improve stand health by stopping or reducing the actual or anticipated spread of insects and disease (Helms 1998).

⁵ A BA of 90 helps reduce fuel loads to facilitate prescribed burning. Disturbance from lowering the BA to 90 is expected to help stimulate new aspen growth while maintaining a spruce and conifer presence. A BA of 90 is also expected to reduce the probability of continued Spruce beetle infestation (Hebertson 2013) and is expected to allow for trees to grow bigger.

⁶ Uneven-aged management – a planning sequence of treatments designed to maintain and regenerate a stand with three or more age classes (Helms 1998). This is opposed to even-aged management that describes a stand as trees composed of a single age class.

	Existing Vegetation	Mechanical and Associated Slash Burning
Alternative 2	Seral Aspen	3,146
	Stable Aspen	4,025
	Spruce/Fir	918
	Mixed Conifer	97
	Total	8,186
Alternative 3	Seral Aspen	6,422
	Stable Aspen	4,780
	Spruce/Fir	2,355
	Mixed Conifer	91
	Total	13,648
Alternative 4	Seral Aspen	9,492
	Stable Aspen	6,130
	Spruce/Fir	4,113
	Mixed Conifer	102
	Total	19,837
Alternative 5	Seral Aspen	6,736
	Stable Aspen	5,340
	Spruce/Fir	2,905
	Mixed Conifer	92
	Total	15,073

Table 2: Option 1--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

	Existing Vegetation	Mechanical and Associated Slash Burning (Acres Outside IRAs and UUAs)	Mechanical and Associated Slash Burning (Acres Inside IRAs and UUAs)	Project Total
Alternative 2	Seral Aspen	2,349	797	3,146
	Stable Aspen	3,643	382	4,025
	Spruce/Fir	472	446	918
	Mixed Conifer	89	8	97
	Total	6,553	1,633	8,186
Alternative 3	Seral Aspen	3,111	3,311	6,422
	Stable Aspen	3,965	815	4,780
	Spruce/Fir	835	1,520	2,355
	Mixed Conifer	90	1	91
	Total	8,001	5,647	13,648
Alternative 4	Seral Aspen	3,991	5,501	9,492
	Stable Aspen	4,196	1,934	6,130
	Spruce/Fir	1,186	2,927	4,113
	Mixed Conifer	91	11	102
	Total	9,464	10,373	19,837
Alternative 5	Seral Aspen	2,547	4,189	6,736
	Stable Aspen	3,830	1,510	5,340
	Spruce/Fir	984	1,921	2,905
	Mixed Conifer	91	1	92
	Total	7,452	7,621	15,073

Table 3: Option 2--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

Proposed Prescribed Fire Treatments

Prescribed fire would be implemented utilizing aerial and/or hand ignition techniques targeting spruce/fir, mixed conifer, and seral aspen with mosaic burn patterns and mixed burn severities as an objective. To maintain LRMP compliance, prescribed fire would occur when 60 percent of the area would be expected to burn (Table 4).

	Existing Vegetation	Prescribed Fire Mixed Burn Severities (Acres)	Prescribed Fire - Mixed Burn Severities Factoring 60% of the Acres Get Burned
Alternative 2	Seral Aspen	15,159	9,095
	Stable Aspen	7,991	4,795
	Spruce-Fir	5,658	3,395
	Mixed Conifer	4,183	2,510
	Total	32,991	19,795
Alternative 3	Seral Aspen	14,318	8,591
	Stable Aspen	7,861	4,716
	Spruce-Fir	4,988	2,993
	Mixed Conifer	4,190	2,514
	Total	31,357	18,814
Alternative 4	Seral Aspen	12,763	7,658
	Stable Aspen	6,693	4,016
	Spruce-Fir	3,802	2,281
	Mixed Conifer	4,178	2,507
	Total	27,436	16,462
Alternative 5	Seral Aspen	11,676	7,006
	Stable Aspen	6,777	4,066
	Spruce-Fir	3,810	2,286
	Mixed Conifer	4,190	2,514
	Total	26,453	15,872

Table 4: Proposed prescribed fire treatments.

Design Criteria and Mitigation Measures

Design criteria are described in detail in chapter 2 of the EIS. See chapter 2 for additional information.

Monitoring

Burn Monitoring

Direct fire effects would be monitored as required in each burn plan. These are primarily the direct effects of the burn itself: daily weather, smoke, acres burned, flame length, rate of spread. Each burn plan will spell out precisely what is required and who will perform the monitoring.

Browse Thresholds and Response Options

The Monroe Mountain Working Group (MMWG) submitted to the Fishlake National Forest a document titled *Browsing Thresholds and Adaptive Management Pursuant to Aspen Restoration on Monroe Mountain* (MMWG 2014). The MMWG recommended this document for inclusion and analysis in the EIS. The Forest has reviewed this document and is proposing to adopt the browse thresholds and response options recommended by the MMWG. The document in its entirety is located in Appendix D and is hereby incorporated by reference. The UDWR and the Utah Wildlife Board have reviewed and support this document. Chapter 2 of the EIS includes a summary of the browse thresholds and response options.

Manning Meadows and Barney Lake Fencing

Regardless of which alternative is selected, treatment areas adjacent to Manning Meadows Reservoir and Barney Lake would be fenced to exclude both wildlife and livestock browsing (Figure 7). With fencing, the amount of time needed to acquire a minimum of 1,000 aspen saplings per acre is expected to be quicker. Other vegetation and cover types are also expected to benefit from fencing.

The District is proposing to construct approximately 7.2 miles (633 acres) of temporary fence in the Manning Meadows Reservoir and Barney Lake areas (Figure 7). This fence would be approximately 8 feet tall and constructed with net wire, t-post, and wooden post. Maintenance of the temporary fence would occur for 4 to 6 years until the aspen shoots are greater than 6 feet tall, after which the fence would be removed.

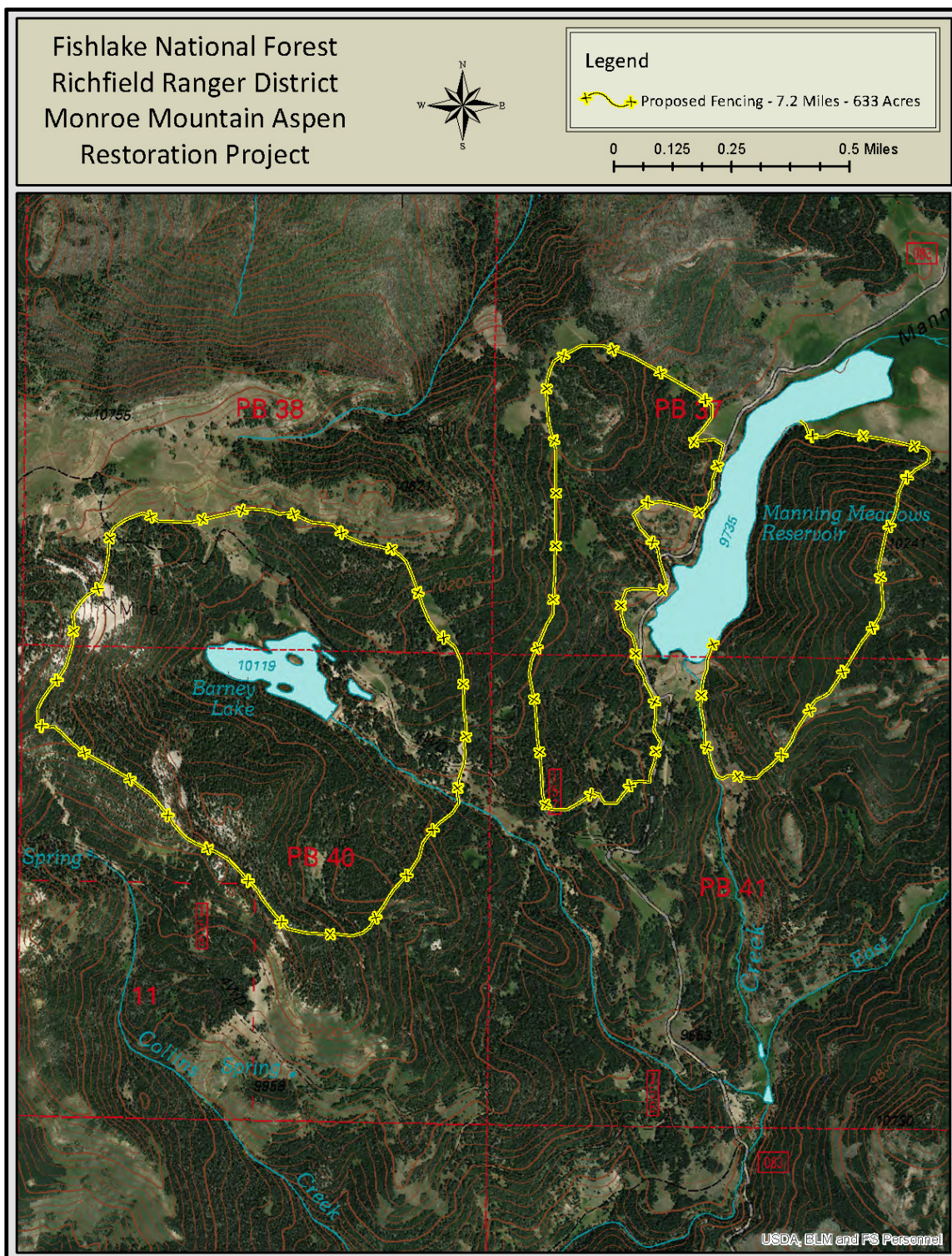


Figure 7: Proposed fencing near Manning Meadows Reservoir and Barney Lake

Affected Environment – Existing Condition

1. Background and history of the Monroe Mountain area
2. Fire history and ecology
3. Recent fire occurrence

1. *Background and history of the Monroe Mountain area*

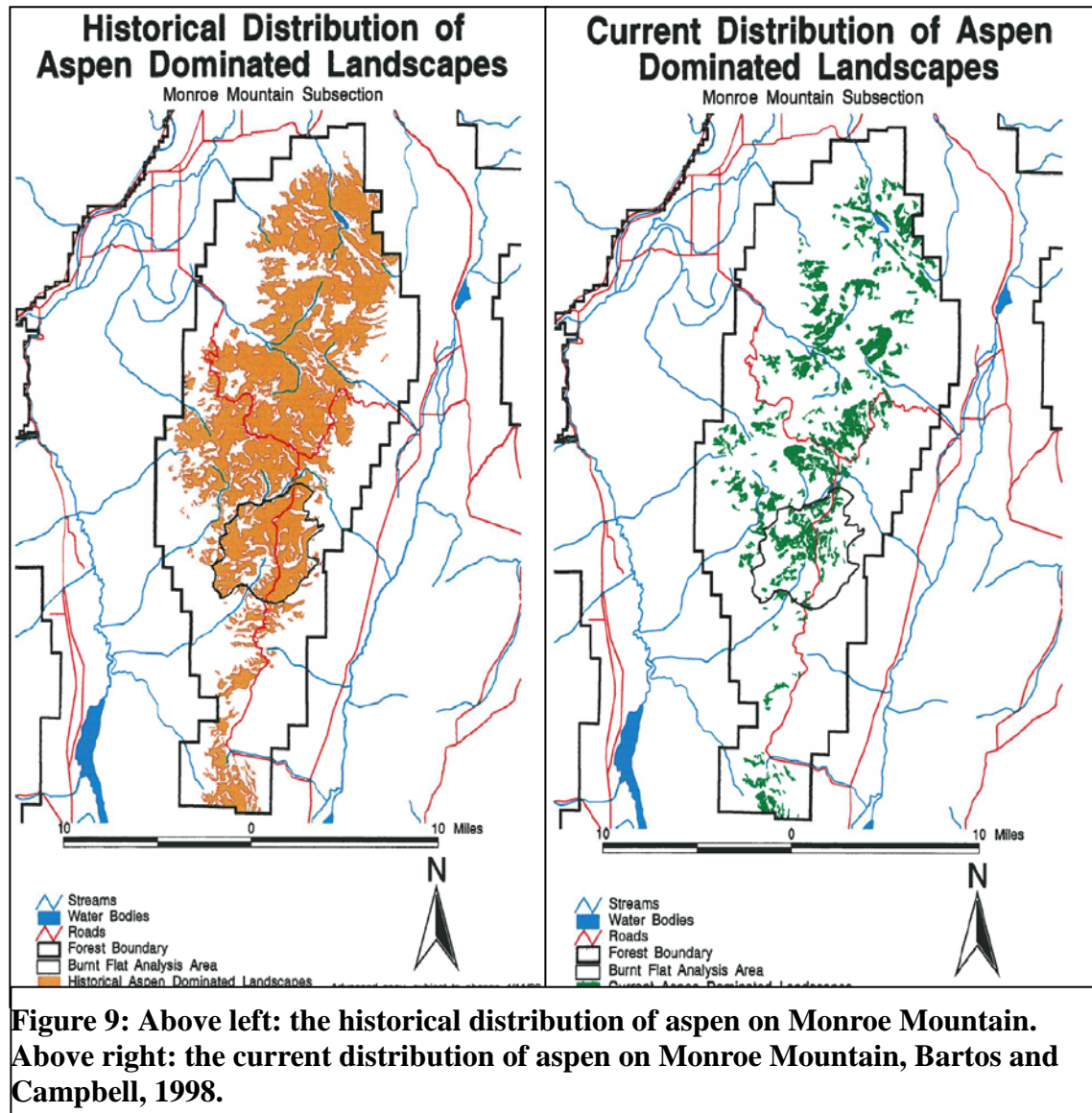
Why the concern about loss of aspen ecosystems? Aspen are considered a keystone ecosystem in central Utah. “Quaking aspen (*Populus tremuloides*) are unique because, in contrast to most western forest trees, they reproduce primarily by suckering from the parent root system. Generally, disturbance or dieback is necessary to stimulate regeneration of aspen stands. These self-regenerating stands have existed for thousands of years. If they are lost from the landscape, they will not return through normal seeding processes as do other tree species.” (Bartos and Campbell, 1998).

This loss of aspen ecosystems then leads to loss of ecosystem sustainability and overall ecosystem biodiversity in direct opposition to the Fishlake Forest Plan direction to sustain biodiversity (Fishlake LRMP, 1986). Aspen historically was a landscape dominant on Monroe Mountain and a number of papers have been published utilizing data collected, summarized and analyzed from the Monroe Mountain area.



Figure 8: Information gathered through fire histories and from interpretation and analysis of the Soil Resource Inventory indicates that with no change in the prevailing conditions most aspen stands within the Project Area will eventually be replaced by conifer.

“Loss, or potential loss, of aspen dominated stands on these lands can be attributed primarily to a combination of successional processes, reduction (or elimination) of fire, and long-term overuse by ungulates.



Existing conditions indicate that most aspen stands will eventually be replaced by conifers, sagebrush or possibly other shrub communities. The decline of aspen results in reduced water yield, forage, and biodiversity. Numerous landscapes throughout the West that were once dominated by aspen are in late successional stages dominated by mixed-conifer. If restoration treatments are to be successful, action must be taken soon” (Bartos and Campbell, 1998). Bartos and Campbell use multiple streams of evidence to show that it is likely more than 70% of properly functioning aspen ecosystems have been lost from Monroe Mountain in the recent past (Figure 9).

Aspen ecosystems support the highest level of biodiversity for interior western forests and the productivity of aspen ecosystem understories (grass, forbs, and shrubs) is higher than all other forest types. “Aspen landscapes in the West provide numerous benefits, including forage for livestock, habitat for wildlife, watershed protection, water yield for downstream users, esthetics, sites for recreational opportunities, wood fiber and

landscape diversity” (Bartos and Campbell, 1998). Individual aspen trees arise almost exclusively from root suckers and are relatively short-lived (i.e., 100 to 200 years). Aspen is shade intolerant and sprouts heavily following disturbance, such as fire, and benefits from disturbance especially where conifer currently shades and competes with aspen.

The 1998 Bartos and Campbell Fishlake-based publication is now 16 years old and conditions have continued to deteriorate for many aspen ecosystems across Monroe Mountain. The downward trend in properly functioning aspen ecosystems continues across the mountain today, slowed only by the few, relatively small fires and forest vegetation treatments which have produced regeneration and some recruitment once protected.

Fire size and pattern has been influenced by changing land use.

Monroe Mountain is currently vegetated with fire adapted and fire dependent species across much of its area. As one scans the landscape, it is evident that the vegetation evolved with fire as the aspen/conifer patterns show below (Figure 10). It is also apparent that fires have not functioned within their historic cycles for more than a century as evidenced by the large number of historic aspen stands now overtopped by conifers across the ecosystems. Low intensity surface fires and stand replacing fires occurred at regular intervals historically, more than 250 years ago (Chappell, et al. 1997, Heyerdahl, et al. 2011).



Figure 10: In this landscape view of Langdon Mountain, there is evidence of two historic fires, leaving two different stands of aspen of different ages and succession intervals. The large aspen stand in the left occurred from a fire in 1890's and the stand to the right is an older fire that occurred in the 1840's and is being replaced by conifer. However, if one were to look under the aspen canopy of the 1890's fire, subalpine fir trees are there and haven't exceeded the aspen canopy yet.

There are good indications that both lightning ignitions and human-caused ignitions contributed to fire's role on the land, historically. "The Indians here seem to be possessed with the spirit of burning, for there is scarcely a day but what we can see fires both on the mountains and in the valleys. We have talked to them about burning up the grass, and they seem willing to spare it, and do set their fires among the sage brush, but it often gets into the grass, and they have already burned much of it, but they try to clear themselves by saying that it will be very good when the rains come in the fall" (Desert News, 1855).

"Prior to establishment of the Forest Reserves in 1891, most of the Intermountain Region had undergone major short-term changes in plant cover as a result of extensive use timber harvesting, livestock grazing and fire exclusion. The landscapes we see today often do not resemble what was present when the first European explorers arrived in the early 1800s." (Ogle and DuMond 1997).

Fire patterns began to change dramatically beginning at the time of European settlement in the mid-1800s, when livestock began grazing the valleys and mountain ranges (Jackson et al. 1998). Settlers moved into Sevier Valley in the early 1860s. By the

1870s, many of the surrounding valleys were also settled by incoming Europeans, increasing pressure on the vegetative resources. Livestock grazed the vegetation in the valleys during the winter, and followed the green vegetation up into the mountains during the summer. Deer and elk numbers have increased substantially in the project area over the past 100 years.



Figure 11: This photo shows typical aspen stands on Monroe Mountain that are converting to sagebrush.

This increased grazing reduced much of the fine surface fuel which previously carried the frequent fires. Additionally, successful fire suppression over the past 100 years has almost totally excluded even more of the frequent low to moderate severity fires which had occurred historically. Historic fires (pre-European settlement) consumed a lot of the fine fuels and mixed-conifer seedlings that produced low and mixed severity fires. More than 100 years of fire exclusion have created an environment conducive to uncharacteristic fires, exceeding historic levels of size and/or severity during much of the currently known fire season. These fires would be more resistant to firefighting efforts and potentially more destructive to private and public property than is desirable or acceptable.

2. Fire history and ecology

Successful fire exclusion or reduced fire frequency has led to late successional plant species domination (e.g., conifer species replacing aspen) accompanied by accumulation

of heavy fuels and loss of understory plants. The available fuels are now taller, denser, more continuous, and more tons per acre are available to burn. This is especially true in areas within the project area that have changed from aspen to a mature mixed conifer.

Loss or potential loss, of aspen on these lands can be attributed to a combination of successional processes, reduction (or elimination) of fire, and long term over use by ungulates. Existing conditions indicate that conifers, sagebrush, or possibly shrub communities will eventually replace most aspen stands. The decline of aspen results in loss of water, forage, and biodiversity. Numerous landscapes throughout the West that were once dominated by aspen are late in successional stages dominated by mixed conifer. If restoration treatments are to be successful, action must be taken soon (Bartos 1998).

Historically, vegetation in the Monroe Mountain area was fire adapted. Fire played a regular disturbance role in these ecosystems, varying by ecosystem. Low severity surface fires and stand replacing fires occurred at regular intervals (Chappell, 1997, Heyerdahl et al, 2011). Many of the plant communities present were prevented from completing the successional path to the climax community stage because of wildland fires. Specific examples of these 'disclimax' plant communities include grass-forb dominated ranges and parklands, and aspen communities which are found across Monroe Mountain. Fire patterns began to change dramatically beginning at the time of European settlement in the mid-1800s, when livestock began grazing the valleys and mountain ranges (Jackson, et. al, 1998).

Another source provides additional evidence of fire as a dominant ecosystem process in preceding centuries. Heyerdahl, Kitchen, Brown and Weber (2006) studied fire-scarred tree samples from five areas, located on four different mountain ranges on the Fishlake NF. Their data from 1,482 crossdated tree samples reveal a distinct shift in how frequently fires burned on these mountains. Prior to 1850 (with data back to 1200 in one area), most of the areas experienced a couple to many fires during each century. Since 1850 few fire years were recorded in fire-scarred trees, and since 1925, essentially no fires burned on most of the areas studied on the Fishlake National Forest (Campbell, 2011).

Aspen-mixed conifer communities on Monroe Mountain developed with fire as an historical disturbance process. Published multi-century fire histories for Monroe Mountain and five regional landscapes with similar topography and vegetation reveal patterns of abundant fire prior to Euro-American settlement in the mid to late-1800s (Heyerdahl et al. 2011). For four sites, stand demographics, surface fire frequency, and fire severity were characterized for plots arranged in grids to represent a broad range in elevation and vegetation type within small watersheds. Aspen was found in 62 percent (59 of 95) of the study plots. Of these, 53 percent were classified in low to mixed severity fire classes with short to moderate fire-free intervals while the remaining plots were classified as having high fire severity and assumed longer intervals. Fire-scarred ponderosa pine trees (*Pinus ponderosa*) sampled on Old Woman Plateau revealed a consistent pattern of frequent surface fire from the 1500s to the late 1800s. This site is located approximately 40 miles northeast of Monroe Mountain and like much of the east-central and southern portions of Monroe Mountain is characterized by gentle terrain with small stands of aspen separated by openings of mostly non-forested sagebrush steppe.

Reported fire evidence from Monroe Mountain was limited to 10 fire-scarred ponderosa pine trees sampled from across a large portion of the mountain. Although ponderosa pine is an excellent species for preserving long records of surface fire, it is an uncommon species on Monroe Mountain and as such is not sufficiently abundant to drive fuels and fire dynamics. However, the short to moderate fire frequency evident from the sampled trees (Figure 12) is supported by widespread evidence of past fire in the form of fire-injured Douglas fir (*Pseudotsuga menziesii*) and Engelmann spruce trees (*Picea engelmannii*; including multiple injuries per tree; Figure 4) and charred remnants. Collectively, this site-specific evidence and data from the intensively sampled regional sites support an interpretation of historic fire-regimes that included a range of short to long fire-free intervals and low to high fire severity, creating and maintaining a diverse and dynamic vegetation mosaic across time and space. These spatially complex fire regimes ended within decades of Euro-American settlement. As a result, structural and compositional diversity was lost as forest communities became dominated by late seral conditions. In mixed stands, aspen cover and viability decreased due to the lack of disturbance over the past 150 plus years. Although persistent or stable aspen (little or no conifer present) may not be dependent upon periodic fire for regeneration, the evidence suggests that fire was sufficiently abundant across these montane landscapes such that even these conifer-free aspen communities were likely exposed to fire periodically.

A fire history completed on Monroe Mountain in 1998 concluded that fire's role had been recurrent until the early 1800s when the local culture changed. Fire exclusion, livestock grazing patterns and livestock use, and other management activities combined to limit fire's previous role in the area's ecosystems. Data summaries show that current levels of fire is lacking when compared to historical levels. Consequently vegetation on much of the landscape has grown for long periods, sometimes equal to many times that of historic mean fire intervals without fire. (Chappell et al, 1998). This has created changes in vegetation composition and structure increasing both live and dead fuel loads and ecosystems which are struggling to function without fire. Table 5 describes 'fire return intervals' which are more important than an 'average fire return interval'. If an area hasn't burned within the interval it is even more at risk of an uncharacteristic fire in either size or severity.

Elevation	Average Fire Return Interval Range	Historical community type	Habitat Type	Number of fire Cycles Missed	Vegetation Structure and Composition
9500+	40-100	Doug-fir/Aspen (Subalpine fir/Englemann spruce)	Subalpine fir/Engelmann spruce	2-4	aspen acted as a tall shrub or sub-dominant tree
8000-9500'	15-40	Ponderosa pine/Aspen	Douglas-fir	4-10	aspen would be uneven-aged with biodiverse understory
below 8000'	35 to 75	sagebrush/grass/forb and mountain brush	Utah Juniper/Pinyon pine/Ponderosa pine	3-6	aspen have multi-aged stems, sagebrush less than 15% cover and a biodiverse understory

Table 5: Changes in Fire's Role from Monroe Mountain Data.

Chappell, et al, 1997.; Heyerdahl, E., et al, 2011.

Fire severity varied with fire frequency, driven by fuels, weather and topographic variation, so widely mixed fire regimes based on fire severity were present. Low, mixed and high severity fires occurred in all watersheds sampled around Monroe Mountain historically with little to no evidence of these fires after the mid- to late-1800s; thus increasing tree densities across southern Utah as a whole, increasing conifer density due to loss of fire over and above densities found in historic plot data. Ongoing research in regards historic fire regimes in aspen concludes that prior to Euro-American settlement, aspen in Utah persisted in both aspen- and conifer-dominated forest patches, the composition and dynamics of which varied in response to temporal and spatial variation in fire regime parameters (Kitchen, unpublished data on file at the USFS Shrub Sciences laboratory, Provo, UT).

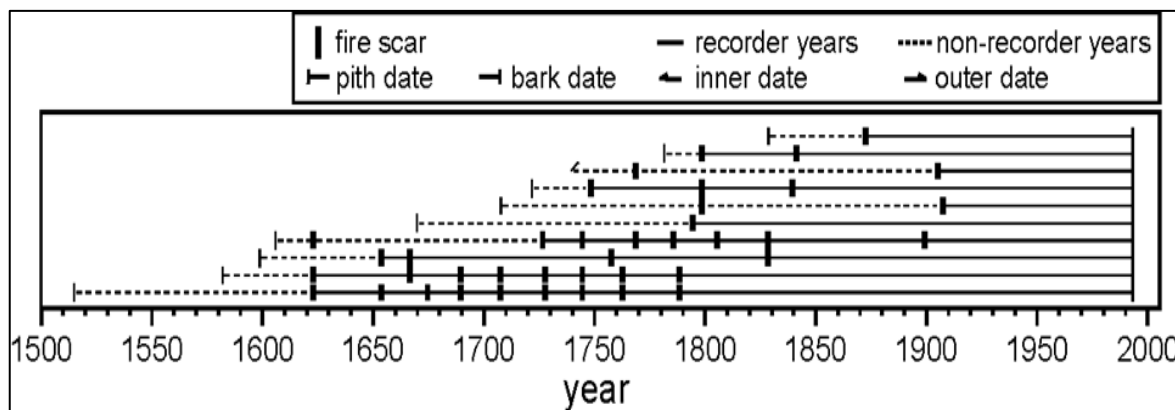


Figure 12: Chronologies of surface fires at Monroe Mountain, sampled over an approximately 35-mile north south transect. Each horizontal line indicates the length of record for a single tree. The short vertical lines indicate years when that tree had a fire scar. Recorder years (solid lines) generally follow the first scar on each tree. Non-recorder years (dashed lines) precede the formation of the first scar on each tree, but also occur when a period of the fire record was consumed by subsequent fires or decay. Inner and outer dates are the dates of the earliest or latest rings sampled for trees where pith or bark was not sampled (Heyerdahl et al. 2011).

Figure 14 below demonstrates that it is likely historical fires burned in the summer, and throughout much of the year. When surface fires cause partial damage to bole cambium, fire seasonality can be roughly deduced from the intra-ring location of resulting injuries. For example, early-season fires create fire scars in early early-wood while fire scars from late-season fires are often located in the late early-wood or latewood. In temperate forests of the Northern Hemisphere, fire scars located at the boundary between annual growth rings could indicate late-season fire after the growth ring is fully formed or early-season fire of the following year before growth of a new ring is initiated. Locations with a high proportion of fire scars located at the ring boundary are indicative of a high proportion of early-season or late-season fires, or both. This information can then be compared to the seasonal distribution of dry lightning occurrence and timing of fuel desiccation to assess the probability of natural verses human ignition sources.

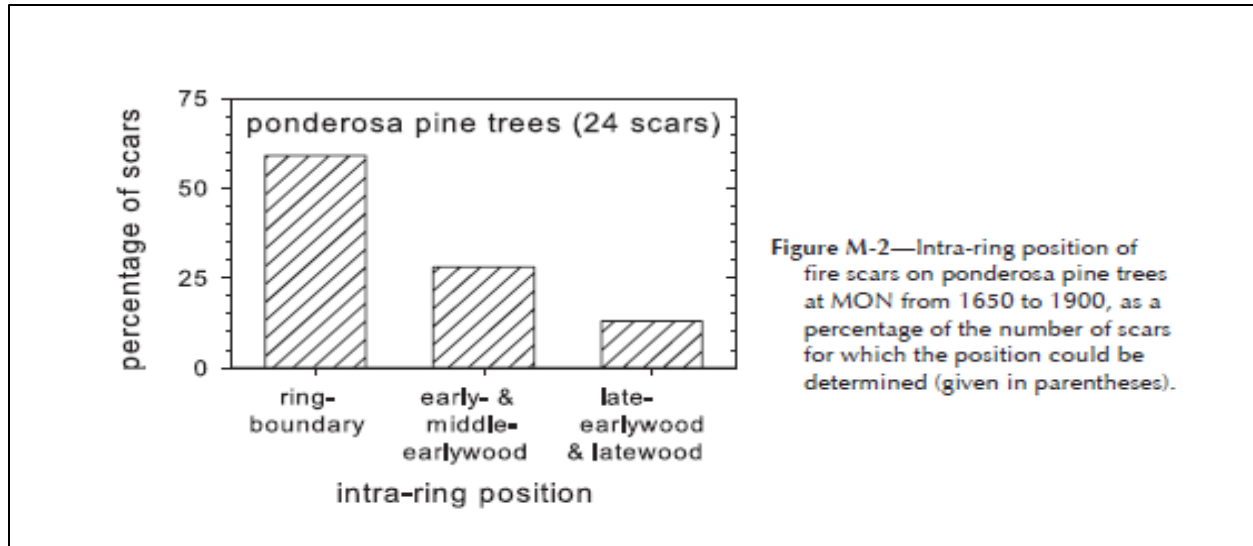


Figure 13: Monroe Mountain Fire Scar Seasonality

A limited analysis of fire A limited seasonality for fire-scarred ponderosa pine on Monroe Mountain suggests that early-season fire dominated pre-1900 fire regimes. In contrast, dry lightning occurrence peaks in the mid- to late-summer. To the extent this limited analysis reflects patterns across the mountain, it suggests a high probability that intentional or accidental ignitions by Native Americans contributed substantially to the overall fire regimes on Monroe Mountain before 1900.

3. Recent Fire Occurrence

The fire occurrence data base for the Monroe Mountain area shown below is summarized from 1951 to 2013. Fire occurrence is displayed beginning at the top left chart. During the 62 year time span, 272 known ignitions occurred and burned 8807 total acres of land. There is a range from 0 fires to 15 fires per year. The acreage per year was widely divergent, from none to over 2000. There were so few acres burned during many years from 1951 to 1977 that acreage didn't register on this chart (acreage shown in blue hatch marks).

Only two years have had fires that burned more than 2000 acres in over 60 years. Marysvale Peak, Annabella and Blackbird Mine fires burned in 2006 and the Box Creek Fire burned in 2012. More than 80% of the ignitions burned less than a quarter acre each, as displayed in the lower left box as size class A. Only four ignitions burned more than 1000 acres each, again in the lower left box as size class F. The lower central box displays that more than 80% of the ignitions in the last 62 years have been lit by lightning. Humans have ignited 17% of the reported fires and just over 10% were caused by debris burning. This is higher than the Fishlake Forest wide average at 6.6%.

Size Class	Fire Size (acres)	Cause Class	Ignition Type
A	0 - 0.25	1	Lightning
B	0.25 - 10	2	Equipment
C	10 - 99	3	Smoking
D	100 - 299	4	Campfire
E	300 - 999	5	Debris Burning
F	1,000 - 4,999	6	Railroad
G	5,000 +	7	Arson
		8	Children
		9	Miscellaneous

Table 6: Fire Size Class and Cause Class Rating Categories for Wildland Fire.

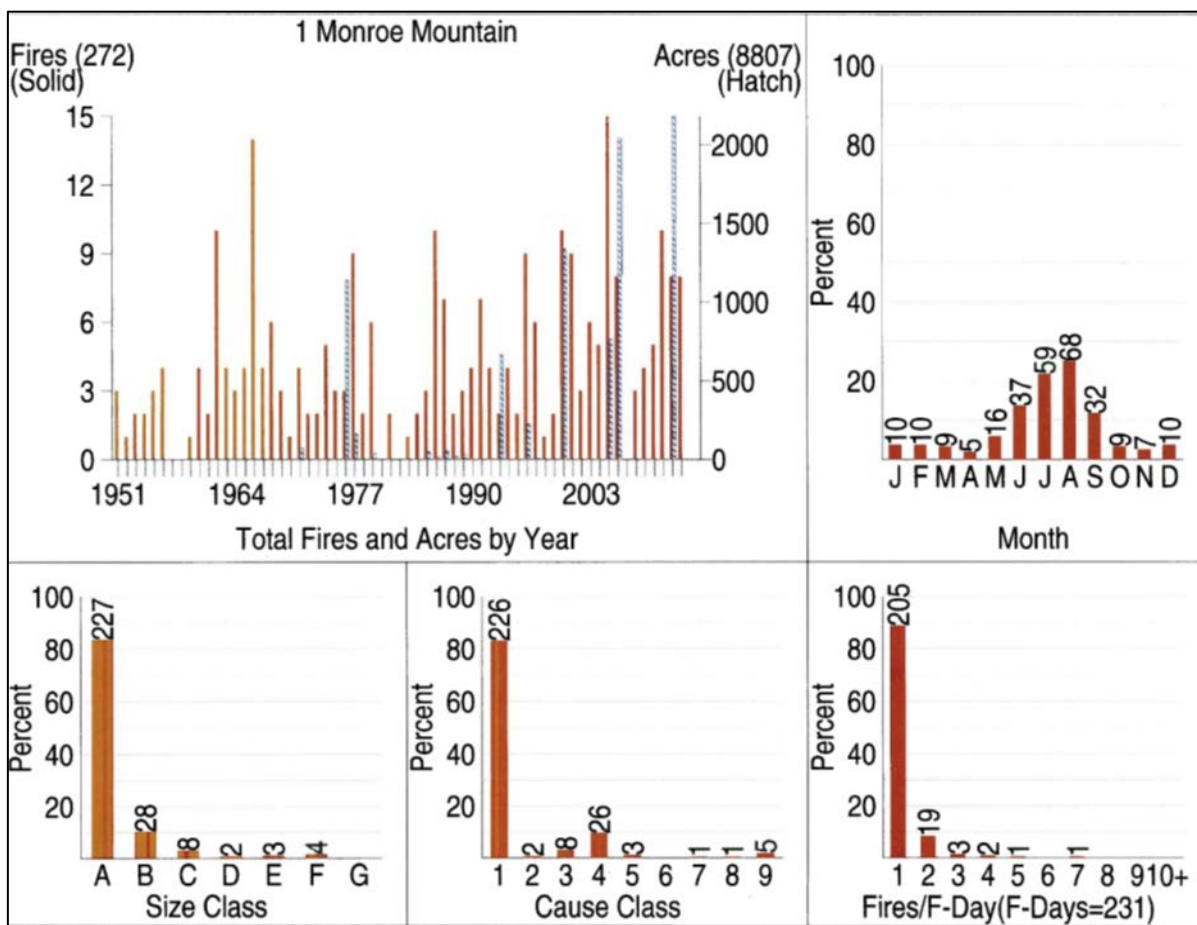


Figure 14: Fire Occurrence on Monroe Mountain for 1951-2013, cumulative effects area, Fishlake National Forest.

5. Vegetation Change Over Time

The Fishlake National Forest wrote a Prescribed Natural Fire plan for the entire forest in 1998. The initial section of that plan was a sub-section by sub-section Properly Functioning Condition Assessment, as described by the Region 4 protocols at the time. (Appendix PFC). Table 7 has evolved from the initial assessment as a monitoring tool for vegetation treatments compared to the desired vegetation condition established at the time.

Largely due to a reduced occurrence of wildland fire, an increase in wildland fire suppression, and overbrowsing, most of the aspen ecosystems on Monroe Mountain presently do not meet the desired conditions described further in the document. Most of the aspen stands on Monroe Mountain do not have multi-height stems and adequate recruitment to perpetuate the communities. Big sagebrush in several areas is a major component, and fire return intervals have not been adequate to perpetuate aspen in areas that are now seral to conifer. Sustainability of these diverse fire-adapted aspen ecosystems will largely depend on the successful reintroduction of appropriate disturbance processes, and reduction in overbrowsing of aspen. Currently it is difficult for managers to allow fire to play a natural role in the ecosystem due to high stand densities, abundant fuel loading, the forest's proximity to private property, and public and firefighter safety. The long term intent is that future naturally caused fires can be managed (if possible, not suppressed) and allowed to play the greatest feasible natural role in the aspen ecosystems on Monroe Mountain (Utah Fire Plan 2001).

Table 7: Analysis by vegetation cover type for Monroe Mountain. This table originated from the Fishlake National Forest's Prescribed Natural Fire Plan (USFS 1998), updated in 2000, and again in 2014. All numbers (with the exception of the Fire Frequency, which is in years) are by 1,000 acres (e.g., The Area in Historic Condition (200 to 400 years ago) for spruce/fir/mixed conifer is 7,000 acres).

Vegetative Cover Type		Spruce/Fir/Mixed Conifer/Seral Aspen	Aspen Dominated	Ponderosa Pine	Other ⁷	Mahogany	Gambel Oak	Pinyon/Juniper	Sagebrush/ Grass/Forbs	Totals ⁸
Fire Frequency (Years) ⁹		10- 80 ¹⁰	20- 60 ¹¹	5-25	20- 50 ¹²	10- 30	20- 50	10- 30	20- 40	
Area in Historic Condition (200-400 Years Ago)	1,000 Acres	7	71	3	13	15	8	5	53	175
Area in Existing Condition (As of Year 2000)		50 ¹³	17 ¹⁴	0	13	15	7	28	45	175
Net Change from Historical (+/-)		43	-54	-3	0	0	-1	23	-8	0
Area of Desired Condition (Start)		28	50	1	13	15	8	10	50	175
Area in PFC ¹⁵ (-)		5	2	0	3	11	6	2	8	37

⁷ Cover type "Other" is a combination of alpine, mountain brush, riparian, and tall forb.

⁸ Totals may not be exact because of rounding to the nearest 1,000 acres.

⁹ These fire frequency years are averages. As described in section 1.3 of the EIS, fire severities varied between low, moderate, and high. Fire frequencies also varied from short, moderate, to long fire-free intervals. These ranges are intended to reflect averages, acknowledging that some areas may have burned more often and some areas may have burned less often.

¹⁰ Average fire frequencies for spruce/fir may be 10 to 50 years for white fir/Douglas fir and 50 to 80 years for spruce/subalpine fir.

¹¹ Average fire frequencies for aspen may be 20 to 40 years at elevations less than 9,000 feet and 40 to 60 years greater than 9,000 feet.

¹² The fire-adapted community most abundant in this group is mountain brush, which as a fire return interval similar to Gambel oak.

¹³ These 50,000 acres also includes seral aspen.

¹⁴ These 17,000 acres only include aspen dominated areas.

¹⁵ PFC stands for properly functioning condition – The on the ground condition termed PFC refers to how well the physical processes are functioning, PFC is a state of resiliency that will allow a riparian-wetland system to hold together during a 25 to 30 year flow event, sustaining that system's ability to produce values related to both physical and biological attributes. It can provide information on whether a riparian-wetland area is physically functioning in a manner that will allow the maintenance or recovery of desired values, e.g. fish habitat, Neotropical birds, or forage, over time.

Vegetative Cover Type		Spruce/Fir/Mixed Conifer/Seral Aspen	Aspen Dominated	Ponderosa Pine	Other ⁷	Mahogany	Gambel Oak	Pinyon/Juniper	Sagebrush/ Grass/Forbs	Totals ⁸
Fire Frequency (Years) ⁹		10- 80 ¹⁰	20- 60 ¹¹	5-25	20- 50 ¹²	10- 30	20- 50	10- 30	20- 40	
Area Not Suitable for Treatment (-)		0	0	0	0	0	0	3	0	3
Area Available for Treatment (=)		23	48	1	10	4	2	5	42	135
Range of Area to Treat in 5 Year Period ^{16, 17}		1-12	4-12	<1	1	1-2	<1	1-2	5-10	13- 42
1986 Through 1990	Wildland fire	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.3
	Prescribed Fire	0.9	0.0	0.0	0.0	0.2	0.0	0.0	0.9	2.0
	Other	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
1991 Through 1995	Wildland fire	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Prescribed Fire	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	0.5
	Other	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.8	1.4
1996 Through 2000	Wildland fire	1.0	0.2	0.0	0.1	0.0	0.1	0.1	0.2	1.7
	Prescribed Fire	0.1	0.0	0.0	0.2	0.0	0.1	0.1	1.1	1.6
	Other	0.7	0.5	0.0	0.0	0.0	0.0	0.1	1.1	2.4
2001 Through 2005	Wildland fire	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.8
	Prescribed Fire	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.9
	Other	0.7	0.1	0.0	0.0	0.0	0.0	1.4	1.2	3.4
Through 2009	Wildland fire	0.5	0.0	0.0	0.0	0.3	0.1	0.9	0.2	2.0

¹⁶ A 5-year period is the minimum window for planning and monitoring in this analysis.¹⁷ To calculate the range of area to treat in a 5-year period, divide the area available for treatment (e.g., prescribed fire) by each of the years given for the range in fire frequency and then multiply each quotient by 5 years.

Vegetative Cover Type			Spruce/Fir/Mixed Conifer/Seral Aspen	Aspen Dominated	Ponderosa Pine	Other ⁷	Mahogany	Gambel Oak	Pinyon/Juniper	Sagebrush/ Grass/Forbs	Totals ⁸	
Fire Frequency (Years) ⁹			10- 80 ¹⁰	20- 60 ¹¹	5-25	20- 50 ¹²	10- 30	20- 50	10- 30	20- 40		
	Prescribed Fire		0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.3	
	Other		0.0	0.1	0.0	0.0	0.0	0.0	0.6	0.6	1.3	
2011 Through 2013	Wildland fire		1.0	0.5	0.0	0.0	0.0	0.0	0.0	0.5	2.0	
	Prescribed Fire		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
	Other		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	
Acres Currently Being Implemented ¹⁸	Prescribed Fire		3.1	1.0	0.0	0.3	1.1	0.4	1.0	3.7	10.6	
	Other		2.2	0.4	0.0	0.0	0.0	0.0	0.0	0.0	2.6	
Total Area Treated Since 1986 or Currently Being Treated			12.2	3.3	0.0	0.6	1.6	0.7	4.5	11.7	34.6	
Area Remaining for Initial Treatments			10.8	44.7	1.0	9.4	2.4	1.3	0.5	30.3	100. 4	
Initial Treatments Completed and Past the Shortest Fire Frequency Return Interval ¹⁹			3.4	0.1	0.0	0.0	0.2	0.0	0.3	0.9	4.9	

¹⁸ Cove Area, Box Creek Fuels Reduction Project, Monument Peak Fuels Reduction Project, and Twin Peaks Fuels Reduction Project

¹⁹ Areas need to be retreated sometime within the fire frequency return interval to help facilitate staying in PFC. (e.g., pinyon/juniper: anything treated more than 10 years ago would meet this).

Vegetative Cover Type		Spruce/Fir/Mixed Conifer/Seral Aspen	Aspen Dominated	Ponderosa Pine	Other ⁷	Mahogany	Gambel Oak	Pinyon/Juniper	Sagebrush/ Grass/Forbs	Totals ⁸
Fire Frequency (Years) ⁹		10- 80 ¹⁰	20- 60 ¹¹	5-25	20- 50 ¹²	10- 30	20- 50	10- 30	20- 40	
Maximum Area Proposed in the Aspen Restoration Project EIS		12.2	35.1	0.0	0.0	0.0	0.0	0.0	0.0	47.3
Maximum Area Proposed in the Aspen Restoration Project EIS if Mechanical Treatments Occur and 60% of the Prescribed Fire Acres Get Burned ²⁰		9.0	27.3	0.0	0.0	0.0	0.0	0.0	0.0	36.3

²⁰ The Northern goshawk (*Accipiter gentilis*) amendment (USFS 2000) require that 40 percent interlocking crown be maintained in foraging habitat. Prescribed fire would occur when 60 percent of the area would be expected to burn, maintaining 40 percent interlocking crowns and a mosaic burn pattern.

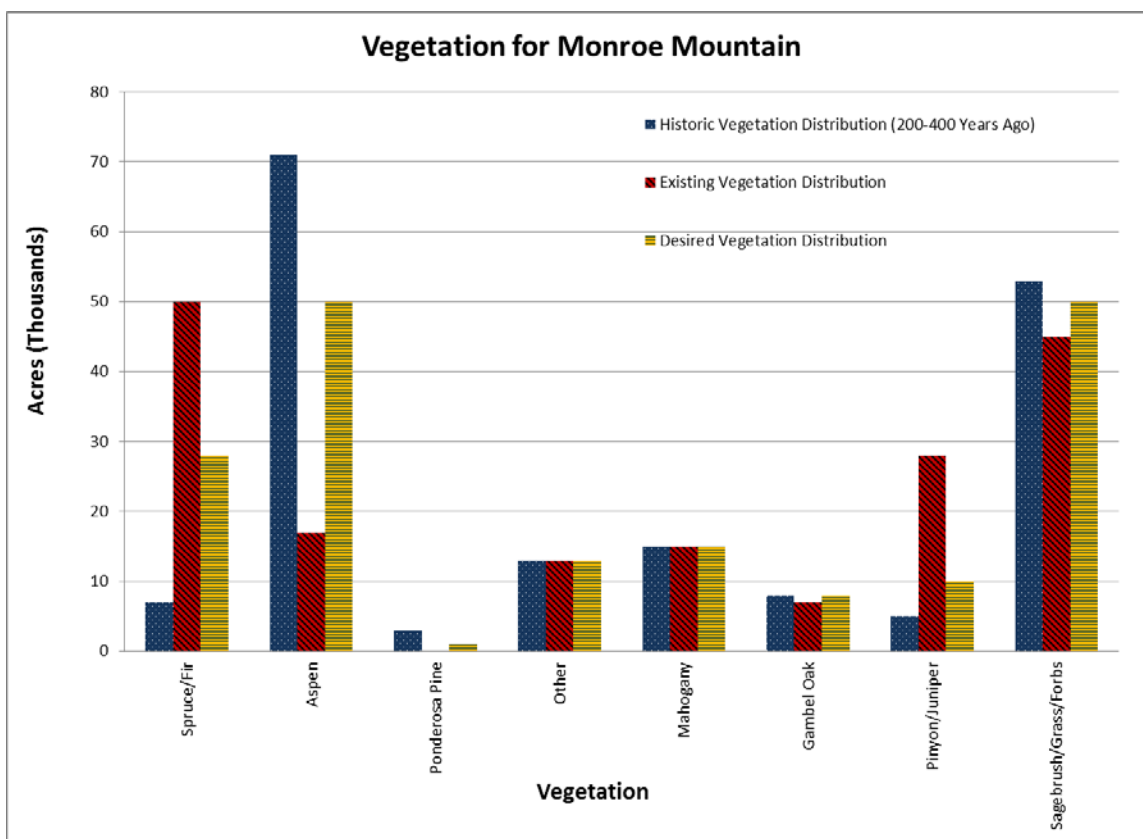


Figure 15: Historic vegetation compared with existing vegetation and desired vegetation (Prescribed Natural Fire Plan, 2000)

Mixed Conifer – Existing Condition

Mixed Conifer types occur across the Monroe Mountain project area at the higher elevations primarily on north facing slopes. These stands consist mainly of older age class Engelmann spruce or Douglas-fir trees intermixed with aspen, white fir, subalpine fir, and mountain shrub. Fire return intervals in this type are typically in the 10-80 year range (Fishlake National Forest, 1998). In those areas where Douglas-fir and white fir are the dominant conifers, fire return intervals are estimated at 10-50 years. Where spruce and subalpine fir occurs, return intervals are believed to be 50-80 years (Jackson, et al., 1998). In areas where spruce occurs without an aspen component, fire return intervals have been documented in the 50 to 300 year range (Bradley, et al., 1992). There are few pure spruce stands within the analysis area. These areas have fairly high fuel loading in the 25 to 60 tons per acre range; (Fishlake 2010 Data Collection) leading the stands to a higher intensity, stand replacing fire regime condition (Ottmar et al., 1998 and Fischer, 1981a). Many of these mixed Douglas-fir and spruce stands in the project area are falling victim to insect and disease attacks, increasing the concentration of dead woody material and contributing to increased fire risk. Fuel loadings during historical times were probably no more than one fourth to one third of present day loadings, or 12 to 18 tons per acre (Dieterich, J. H., 1983).

Aspen – Existing Condition

The aspen within the Monroe Mountain project area historically dominated the higher elevations. Many of these areas that were once pure aspen stands have declined due to the effects of fire exclusion and browsing. Aspen is being overtaken by subalpine fir and Engelmann spruce throughout much of the analysis area. Many of these stands occur on the steep slopes. Fire return intervals in this fuel type have been estimated at 20 to 60 years (Fishlake National Forest, 1998). These areas would have typically been categorized in a low to mixed severity fire regime depending on the amount of conifer present in the understory. Historically, typical fuel loads for these stand conditions were 3 to 10 tons per acre. Today, however, they are more likely to burn under a high severity regime due to the higher presence of conifer in both the understory and overstory. Today, fuel loading under these conditions range from 3 to 50 tons per acre (Fishlake 2010 Data Collection).

Current Fire Behavior and Safety

During the recent uncharacteristic wildfires, fire behavior was more extreme and faster moving than historically. Flame lengths of 50 to greater than 100 feet are common in the mixed conifer fuel types. The typical flame lengths in these fuel types make it extremely difficult for initial attack suppression resources to safely and successfully extinguish fire as shown in Figure 6 and Figure 16. It is not uncommon for wildfires in central Utah to grow to greater than 1000 acres in a single day.

The bottom line is that initial attack, utilizing available engine and hand crews, is likely unsuccessful on hot, dry, windy, days in the heavy, continuous fuel. This makes working conditions unsafe for firefighters and often, the nearby public.

Most of the vegetation (fuels) across the Monroe Mountain project area has experienced fire exclusion for over 150 years, resulting in an atypically high fuel load. Had fires continued to burn as they did historically, a mosaic of fuel loads would be present. Now, the continuous fuel loading increases the risk of a fire easily spreading once it ignites, adding to the wildfire hazard and risk over a larger area.

The 2007 Central Utah Regional Wildfire Protection Plan identified 'Monroe Mountain Area (includes area from Monroe to Glenwood) as a regional priority project. The selection of these areas was based on the need for fuels reductions. The communities at risk in that Project Area are Monroe, Annabella, Monroe Meadows, Manning Meadows, the Koosharem Reservoir area, Long Flat, and Burrville. These are all state-identified Communities at Risk and reducing risk is a priority under the Healthy Forest Restoration Act. There has been strong community interest in fuels reduction and creating defensible space. Sevier County has included the structures on Monroe Mountain as part of the completed Monroe Mountain/Cove Mountain Community Wildfire Protection Plan and begun some private land and structures defensible space work. This includes removal of surface fuels, limbing and pruning trees and brush, and increasing canopy spacing between trees.

Community wildfire protection plans may also document possible practices in the event of wildfire including fire preparedness, evacuation procedures, and opportunities for fire education, mitigation and prevention.

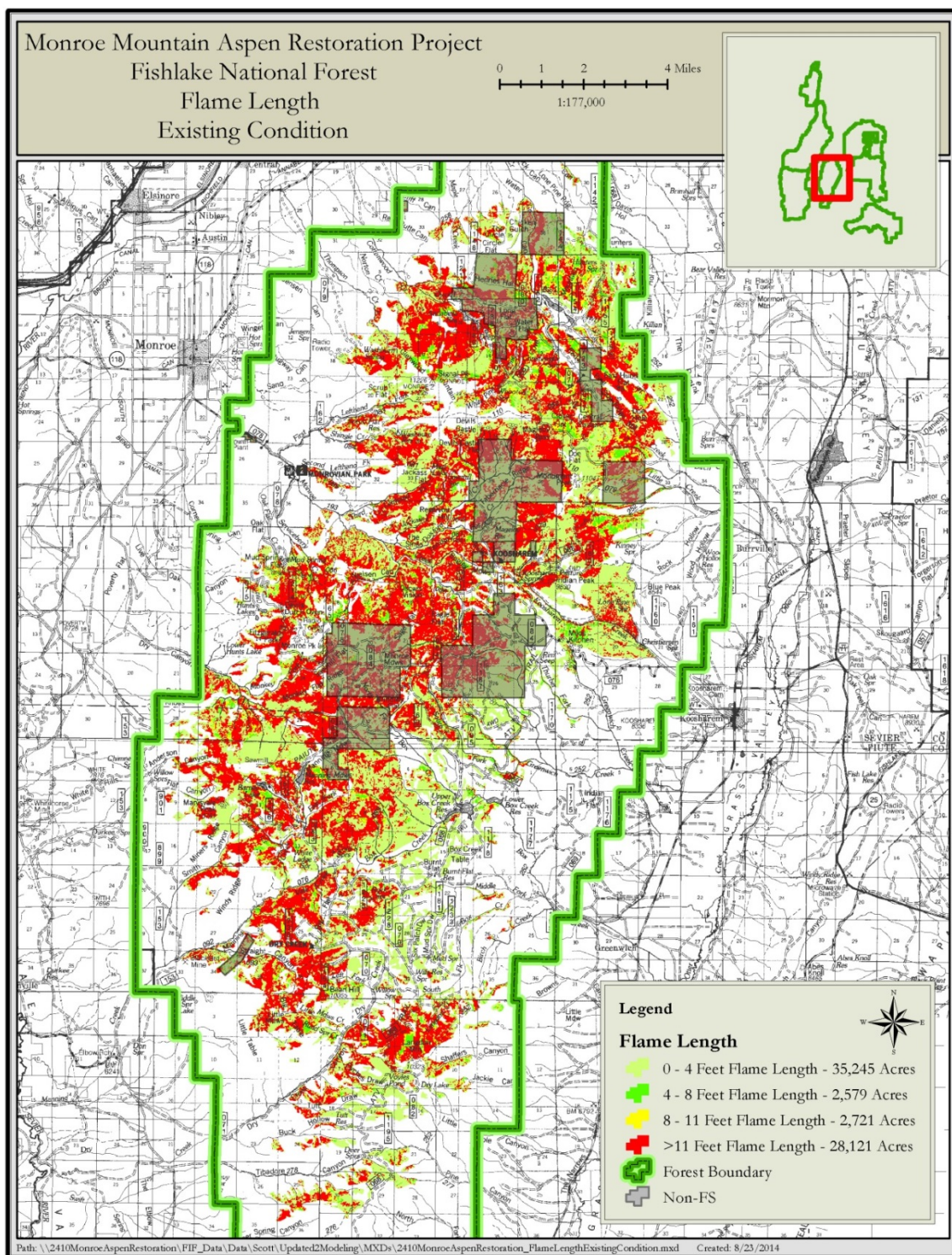


Figure 16: Existing Condition, Flame Length

Topography and Weather

Fuels, weather, and topography describe the fire environment. They work together to define fire behavior. The fuels element of the fire environment is the only element of the fire behavior triangle which can be modified. Appropriate fuels modifications reduce potential fire behavior by changing the distribution, continuity, size and shape of fuels, and fuel loading.

Topographic characteristics that influence fire behavior include slope, aspect, elevation, shape of the land, and the influence of topography on wind. Narrow canyons, box canyons, saddles, chimneys, and chutes all increase fire control problems when compared to other land formations. Topography and topographic shapes can influence wind patterns, convection patterns, and the susceptibility of vegetation outside of the fire to radiant heat from the fire. For example narrow canyons produce a chimney effect for the convection column, preheating fuels located within the “chimney”, narrow canyons can also allow for radiant heat to be transferred from one side (or aspect) of the canyon to the other, thus drying them out and making them easier to ignite.

Slope increases fire behavior by more easily allowing a fire to preheat fuels upslope of the fire and enabling spotting from rolling and aerial firebrands. Flame length and rate of spread increase with an increase in slope. Slopes within the Monroe Mountain project area are moderately steep, and range from <20 on uplands, 30 to 60% on east side of the range and 40 to 80% on the west side of the range.

Aspect is the direction a slope faces and, within the Monroe Mountain project area, all aspects are represented. South and southwest aspects typically experience the more severe fire behavior due to the duration of sun exposure and pre-dominant wind directions in this part of the country. Vegetation located on south or southwest aspects typically contain lighter and flashier fuels when compared to other aspects in the same or similar locations. Heavier fuel loads tend to be on the north aspects. Predominant winds within the project area are generally southwest, with local winds based on the topography

Elevation affects fire behavior in several different ways including the amount of precipitation received, snow melt dates, fuel types and loadings, vegetation curing dates, the overall length of the fire season, and cooler temperatures in higher elevation resulting in shorter individual burn periods.

Summers are typically hot and dry with daytime temperature averaging approximately 85 degrees with single or low double digit relative humidity and poor overnight relative humidity recovery. The monsoonal pattern typically begins to set up in July, but is neither reliable nor predictable. Lightning caused fires occur primarily in July and August associated with the monsoonal pattern typical of the high desert. Often these thunderstorms produce dry lightning and strong winds with little to no moisture.

Desired Condition

The desired condition as outlined in this document is specific to Monroe Mountain and was developed by the District; it is consistent with the Forest’s Land and Resource Management Plan (LRMP; USFS 1986). The desired condition is to have persistent aspen communities, with multi-height stems and adequate recruitment to perpetuate

aspen communities, including site-appropriate, biodiverse understories. Big sagebrush, if present would be a minor component of the aspen community. Fire regimes would be adequate to perpetuate aspen, particularly in areas seral to conifer. Table 8 describes the current and desired aspen stand structure for areas currently classified as seral aspen, spruce/fir, and mixed conifer.

		Aspen Sprouts/Acre (<6 feet in height)			Aspen Saplings/Acre (6-12 feet in height)			Aspen Recruits/Acre (>12 feet in height)		
		Min	Max	Ave	Min	Max	Ave	Min	Max	Ave
Current Condition	Aspen: Seral Stands	0	3,286	592	0	911	119	59	615	276
	Spruce/Fir Stands	0	4,433	1,121	0	183	38	0	301	137
	Mixed Conifer Stands	0	1,255	677	0	233	108	0	286	117
Desired Condition ²¹	Aspen Structure After Implementation of Mechanical and/or Prescribed Fire Treatments	5,000	No Max	10,000 to 20,000	1,000	No Max	1,000 to 2,000	400	No Max	400 to 600

Table 8: Current and desired aspen stand structure in areas currently classified as seral aspen, spruce/fir, or mixed conifer

Aspen sprouts are defined as aspen less than 6 feet in height, aspen saplings are defined as aspen 6 to 12 feet in height, and aspen recruits are defined as aspen greater than 12 feet in height. For seral aspen stands, the disparity between the existing and desired condition is great. The existing condition describes 592 sprouts per acre compared to 10,000 to 20,000 sprouts per acre as described in the desired condition. Similarly, the existing condition describes 119 saplings per acre while the desired condition describes approximately 1,000 to 2,000 saplings per acre. Lastly, the existing condition describes 276 recruits per acre, while the desired condition is 400 to 600 recruits per acre (Table 8). Similar results occur for aspen in the spruce/fir and mixed conifer dominated stands (Table 8). Accomplishing these 10,000 to 20,000, 1,000 to 2,000, and 400 to 600 sprouts, saplings, and recruits per acre would result in achieving the desired conditions described above of having persistent aspen communities with multi height stems and adequate recruitment to perpetuate aspen communities, including site-appropriate, biodiverse understories.

The existing vegetation distribution (Figure 18) shows approximately 29 percent of Monroe Mountain is dominated by spruce/fir, mixed conifer, and seral aspen while approximately 10 percent is dominated by aspen. As shown in (Figure 17), the desire is to have more areas dominated by aspen and fewer areas dominated by spruce/fir, mixed conifer, and seral aspen.

²¹ These numbers demonstrate that the desired condition of having aspen communities with multi-height stems with adequate recruitment to perpetuate the aspen communities are being met.

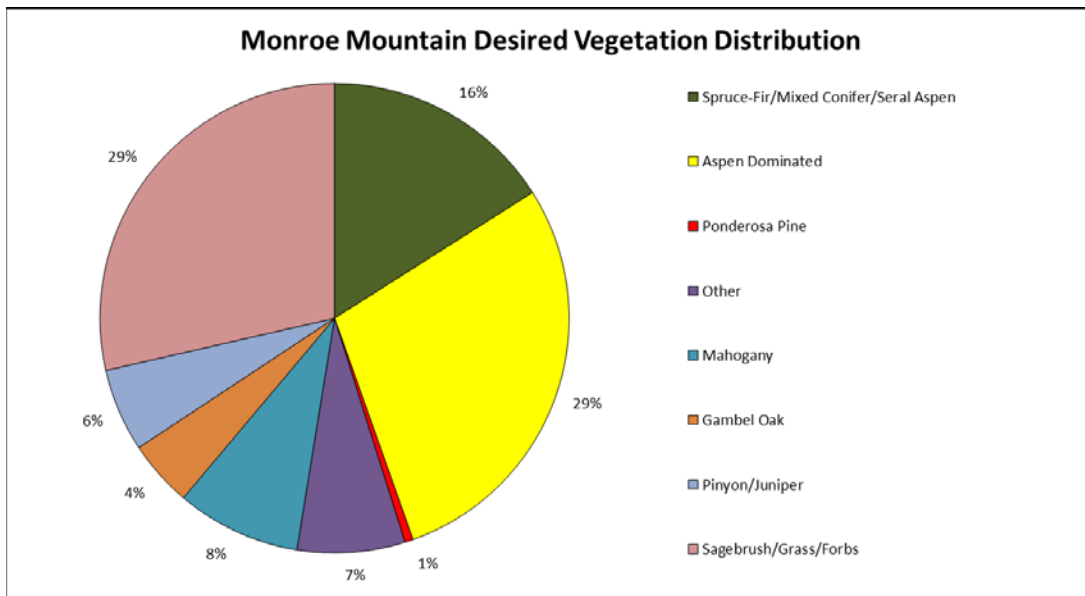


Figure 17: Monroe Mountain desired vegetation distribution

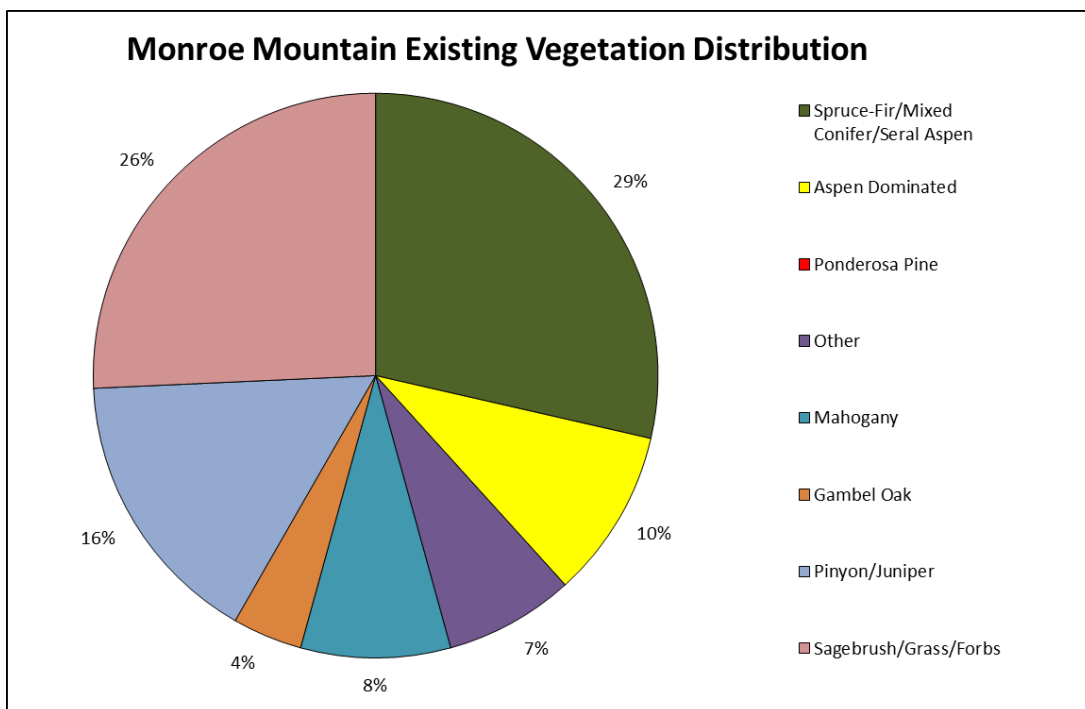


Figure 18: Monroe Mountain existing vegetation distribution

Environmental Consequences

Throughout this section, changes directly attributable to the action alternatives, such as thinning or prescribed fire, and direct effects are described. These include changes to canopy bulk density, canopy base height, consumption of surface fuel, etc. Changes to the potential behavior and effects of wildfires that result from the direct effects are considered indirect effects.

Alternative 1 - No Action

Direct Effects

Under Alternative 1, there would be no changes to current management. The treatment area would not move towards desired conditions in the mixed conifer/aspen ecosystems nor restore disturbance based ecosystems. This alternative would not reduce the wildfire risk to human lives nor would it result in safe, cost-effective fire management that would protect, maintain, and enhance National Forest System lands, or adjacent lands as required by FSM 5100.

This Alternative would not meet the purpose and need. Under this Alternative wildfire, when it occurs, could be detrimental to the ecosystems it burns as well private lands nearby. Wildfire in untreated areas is usually more costly and less efficient to manage than either prescribed fire or wildfire that is managed in areas that have had restoration treatments.

It is likely that large, unmitigated wildfires would continue to occur as this area has had repeated lightning ignitions in the recent past and that lightning pattern is expected to continue. The area has a higher potential for human-caused ignitions as shown by historic data for Monroe Mountain and Fishlake National Forest; see Recent Fire Occurrence section.

Indirect Effects

Effects resulting from Alternative 1 are indirect because there would be no management actions. The effects of implementing Alternative 1 are discussed in the following order. In the short term (<20 years) effects of Alternative 1 would include an increased risk of undesirable fire behavior and effects. Wildfire behavior would threaten lives, resources, and infrastructure. This alternative would not move the area toward desired condition.

In the long term (>20 years) wildfires would likely continue at inopportune times and places while aspen continue to lose function as conifer continue to grow into those stands due to lack of disturbance. The fire return interval would continue to increase in these disturbance-based ecosystems. In addition to allowing surface fuels to buildup, this alternative would allow ladder fuels to grow up in areas on the edges of denser forested areas, and woody species continue to expand into aspen.

With no treatments or disturbance, it would be expected that the aspen would continue to decline. If wildfire burns though aspen, the larger stands could likely respond with

prolific sprouting, as most of the larger recruits are top killed. Recent trends show that browsing pressure would probably prevent the sprouts from reaching maturity so, without some sort of protection or change to ungulate browsing, stands would be weakened as the roots use up carbohydrates trying to keep suckering. Stands that are already declining may be killed, or pushed closer to dying from ungulate browsing, particularly when combined with uncharacteristic fire effects at the wrong time of year. If they did respond by sprouting (likely), browsing of those sprouts would further weaken the stands, and some would disappear. (Amacher, 2001 and Kay, 1993).

Cumulative Effects

Spatially, cumulative effects of projects were evaluated within the Project Area. The prevailing southwesterly winds typically drive fires to the northeast across Monroe Mountain, so fires igniting on the southwest side of the mountain have more potential to burn into the project area than fires further away or in other directions.

Cumulative effects include the effects of wildfire and vegetation management activities (mechanical treatments and prescribed fire) on fire behavior and fire effects. The time frame considered is about 20 years into the past and 10 years in the future at which time the majority of the actions proposed will have been completed.

Past Vegetation Management Projects

Past vegetation treatments and wildfires near, adjacent to, and within the project area have contributed to shaping the existing vegetation conditions for the treatment area with prescribed fire and/or mechanical treatments.

Past Vegetation Management Projects

Past, Present and Reasonably Foreseeable Future Actions on Monroe Mountain			
Name	Type of Action	Year	Acres
Blue Peak	Brushsaw	2003	766
Durkee Fuels	Brushsaw	2004	617
Thompson Basin	Brushsaw	2007	579
Total for last 20 years		1994-2013	1962
Box Creek	Dixie Harrow	1995	29
Burnt Flat	Dixie Harrow	1995	96
Six Patch	Dixie Harrow	1995	440
Six Patch/Rock Springs	Dixie Harrow	1995	109
Squaw Springs	Dixie Harrow	1995	440
Bell Rock	Dixie Harrow	1996	138
Bagley North	Dixie Harrow	1997	47
Little Table	Dixie Harrow	1997	126
Thurber Fork	Dixie Harrow	1998	570

Burnt Flat	Dixie Harrow	1998	316
Forshea Mountain	Dixie Harrow	1999	65
085 Road	Dixie Harrow	2000	22
Big Flat	Dixie Harrow	2003	133
Blue Peak	Dixie Harrow	2003	766
Box Creek	Dixie Harrow	2003	104
Indian Flat	Dixie Harrow	2003	14
Koosharem	Dixie Harrow	2003	76
Six Patch	Dixie Harrow	2003	265
Dry Creek	Dixie Harrow	2004	93
Durkee Springs	Dixie Harrow	2004	466
Hells Hole	Dixie Harrow	2004	132
Indian Flat	Dixie Harrow	2004	89
Rueben Burn	Dixie Harrow	2004	155
Willis Spring	Dixie Harrow	2005	176
Brindley Flat	Dixie Harrow	2006	40
Indian Peak	Dixie Harrow	2006	95
Box Creek Retreat 1	Dixie Harrow	2008	156
Thurber Fork Retreat 1	Dixie Harrow	2009	461
Twin Peaks	Dixie Harrow	2012	578
Totals for last 20 years		1994-2013	6,197
Indian Ranch	Harvest	1969	47
Langdon Mountain	Harvest	1969	17
Monroe Peak	Harvest	1980	14
Pole Canyon	Harvest	1982	19
Big Flat Aspen 4,5 &6	Harvest	1983	4
Lone Pine	Harvest	1984	78
Lower Langdon	Harvest	1984	82
South Monument Asp.	Harvest	1987	17
Clover Flat	Harvest	1989	186
Wooten Spring	Harvest	1989	103
Langdon	Harvest	1991	151
Doe Flat	Harvest	1992	28
Dry Lake	Harvest	1993	46
Cove Mtn. Salvage 1	Harvest	1993	9
Buck Hollow	Harvest	1994	24
Cove Mtn. Salvage II	Harvest	1996	29

White Ledge	Harvest	1997	36
Forshea	Harvest	1998	111
Research Unit	Harvest	1998	12
State Section 16	Harvest	1998	147
White Ledge B	Harvest	1998	71
Monument Peak Salv.	Harvest	1998	60
Dry Creek –State	Harvest	1999	151
Mill #8 Salvage	Harvest	1999	10
Monument Peak Salv.II	Harvest	1999	131
Mill #9 Salvage	Harvest	2000	52
Mill Creek	Harvest	2000	274
White Pine	Harvest	2000	49
Annabella	Harvest	2001	234
Mill #11	Harvest	2001	68
White Pine 2	Harvest	2002	61
Mill #10	Harvest	2003	162
Mill #11a	Harvest	2003	68
Mill 12	Harvest	2004	62
Annabella Aspen II	Harvest	2005	104
Annabella Aspen 3	Harvest	2005	22
North Clover	Harvest	2011	191
Box Creek Phase 1	Harvest	2012	386
Box Creek Phase 2	Harvest	2013	284
Cove Mountain	Harvest	2014	1,774
Monument Peak	Harvest	2014	400
Harvest since 1969		1969-2013	5774
Harvest last 20 years		1995-2014	4949

Table 9: Past, Present and Reasonably Foreseeable Brushsaw, Dixie Harrow and Harvest Treatments.

Prescribed Fire Name	Year	Acres
Kingston Trough	1980	255
Bean Hill	1986	123
Deer Spring	1988	195
Tibadore Pond	1988	669
Deer Spring	1989	41
Buck Hollow	1989	18
Tuft Draw	1989	622
Forshea	1993	1,313
Tibadore Pond	1988	669
Kinney Spring	1996	794
Greenwich Creek	1996	83
Box Creek	1997	509
Little Table	1997	485
Shaffers	1997	334
Jackie Canyon	1997	267
Ruebens	2005	948
Thompson Basin	2008	163
Thompson Basin	2009	180
Box Creek	2012	650
Twin Peaks (project ongoing)	2014	5,169
Monument Peak	2015	3,120
Box Creek	2015	2,658
Total for 34 years	1980-2013	19,265
Total for 20 years	1994-2013	4,847
Total in upcoming years	2014-2015	10,947

Table 10: Past, Present and Reasonably Foreseeable Prescribed Fires.

Wildfire Name	Year	Acres
Hell Hole	1975	896
Monroe Mtn.	1979	8
Monroe Mtn.	1979	67
Kingston Trough	1980	255
Burnt Flat	1983	359
Bean Hill	1986	123
Tibadore Pond	1989	387
Killian Spring	1990	407
Monroe Canyon	1996	196
Thompson Basin	1996	103
Flat	1997	5,505
Oldroyd	2000	1,329
Bald Knoll	2003	68
Marysvale Peak	2005	759
Annabella	2006	573
Blackbird Mine	2006	1,463
Box Creek	2012	1,520
Total for 20 years	1994-2013	11,516
Total for 39 years	1975-2013	14,018

Table 11: Past Wildfires.

The combined effects of the projects listed in Table 10 are limited to 4,847 acres treated with prescribed fire in the last twenty years. Wildfires had a slightly larger impact at 11,516 acres burned in the last 20 years (Table 11). An average of 432 acres per year burned over the 39 years of known fires. Very few wildfires were managed for multiple objectives beyond suppression due to the conditions while they were burning. Sixty percent of the last 20 years of burning treatments have occurred as wildfires.

Unavoidable Adverse Effects, Irreversible and Irretrievable Commitment of Resources

Without treatment, there would be expected more and larger fires of higher severity than occurred historically, or than are sustainable on the landscape. There is broad consensus that such fires will continue to burn in this area if no action is taken, though the specific extent and location of the negative effects could not be known until an incident occurs.

First order effects would include (but are not limited to): chemical and physical changes to soil, high levels of mortality across the burned area (assuming ~30% high severity), consumption and/or killing the seed banks, consumption of organic material in soil, including flora and fauna, conversion of forested habitat to non-forested habitat through loss of the spruce/fir component.

Second order fire effects would include (but are not limited to) erosion, flooding, debris flows, destroyed infrastructure, changes in visitation to the forest and the economies of local businesses that depend on visitors, and degradation of water resources for wildlife and humans. Loss or damage to the Bonneville cutthroat watershed and boreal toad habitat would be more likely under this scenario.

With no treatments or disturbance, the aspen ecosystems would be expected to continue to decline rather than be sustained as functioning ecosystems. It is likely that more and possibly larger wildfires would occur, increasing the likelihood of private lands burning, private property damage and possible large areas of high severity fire impacts. The possibility of human injury or death also rises during these unusual wildfires.

Some of these effects would last just a few days or weeks (infrastructure would be rebuilt), some would take years to recover, some changes would be permanent. For instance, it is likely that where fires occur, continued overbrowsing on the post-fire sprouts would also occur, likely killing the aspen roots, resulting in loss of aspen ecosystems across the project area. Another example is that topsoil is critical to healthy surface vegetation and would take centuries to recover though, with climate change, it is unknown exactly what the ecological trajectory would be. The loss of old growth and old trees would require decades to centuries to recover.

Alternative 2 (Figure 19)

Seral and Stable Aspen Stands – Proposed Mechanical Treatment Methods

There are two mechanical treatment options being analyzed for Alternative 2 for seral and stable aspen dominated stands (Photos 1 to 9; Appendix A):

1. Conifers would be removed and the existing aspen would be retained regardless of the size of the conifer or if it is located within an IRA or draft UUA (Table 12) (Photos 2, 5, and 8; Appendix A). To access the conifer, some incidental cutting of aspen may occur. This option would occur throughout the project area.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH and the existing aspen would be retained (Table 13) (Photos 3, 6, and 9; Appendix A). In all areas outside the IRAs and draft UUAs, conifers would be removed and the existing aspen would be retained regardless of the size of the conifer.

Spruce/Fir and Mixed Conifer Stands – Proposed Mechanical Treatment Methods

There are also two mechanical treatments options being analyzed for Alternative 2 for spruce/fir and mixed conifer dominated stands (Photos 10 thru 18; Appendix A):

1. This option would occur throughout the project area (Table 12) (Photos 11, 14, and 17; Appendix A).
 - a. If present, beetle killed conifer trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (salvage harvest).
 - b. If conifer trees are currently infected by beetles and are in the process of dying, the infected trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (sanitation harvest).
 - c. In areas of spruce/fir or mixed conifer where LRMP stocking levels are below plan guidance due to bark beetle impacts, replanting of spruce or mixed conifer may occur. If the remaining live trees were greater than a BA of 90, the remaining live trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
 - d. If no beetle killed or infected trees are present initially, live trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH (Table 13) (Photos 12, 15, and 18; Appendix A). In all areas outside the IRAs and draft UUAs, treatments would occur as in Option 1 for spruce/fir and mixed conifer.

Roads: This alternative proposes to create 8.8 miles of temporary roads for access to mechanical treatment areas.

	Existing Vegetation	Mechanical and Associated Slash Burning
Alternative 2	Seral Aspen	3,146
	Stable Aspen	4,025
	Spruce/Fir	918
	Mixed Conifer	97
	Total	8,186

Table 12: Alternative 2; Option 1--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

	Existing Vegetation	Mechanical and Associated Slash Burning (Acres Outside IRAs and UUAs)	Mechanical and Associated Slash Burning (Acres Inside IRAs and UUAs)	Project Total
Alternative 2	Seral Aspen	2,349	797	3,146
	Stable Aspen	3,643	382	4,025
	Spruce/Fir	472	446	918
	Mixed Conifer	89	8	97
	Total	6,553	1,633	8,186

Table 13: Alternative 2; Option 2--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

Prescribed fire activities may affect adjacent private property.

The IRAs (Figure 20) and draft UUAs (Figure 21) adjacent to private property would have a 300-foot mechanical treatment buffer completed first. This 300-foot buffer of mechanical treatments would be completed first to prepare for the application of prescription fire. The 300-foot buffer may be sufficient to minimize impacts from prescribed fire to private property. It is important to note that the 300-foot buffer distance was suggested by the public and was drawn on the maps (Figure 20 and Figure 21) without regard to topography (slope, ridgetops, drainage bottoms, etc.), natural fuel breaks, previous treatment areas or wildland fires, existing roads and trails, etc.

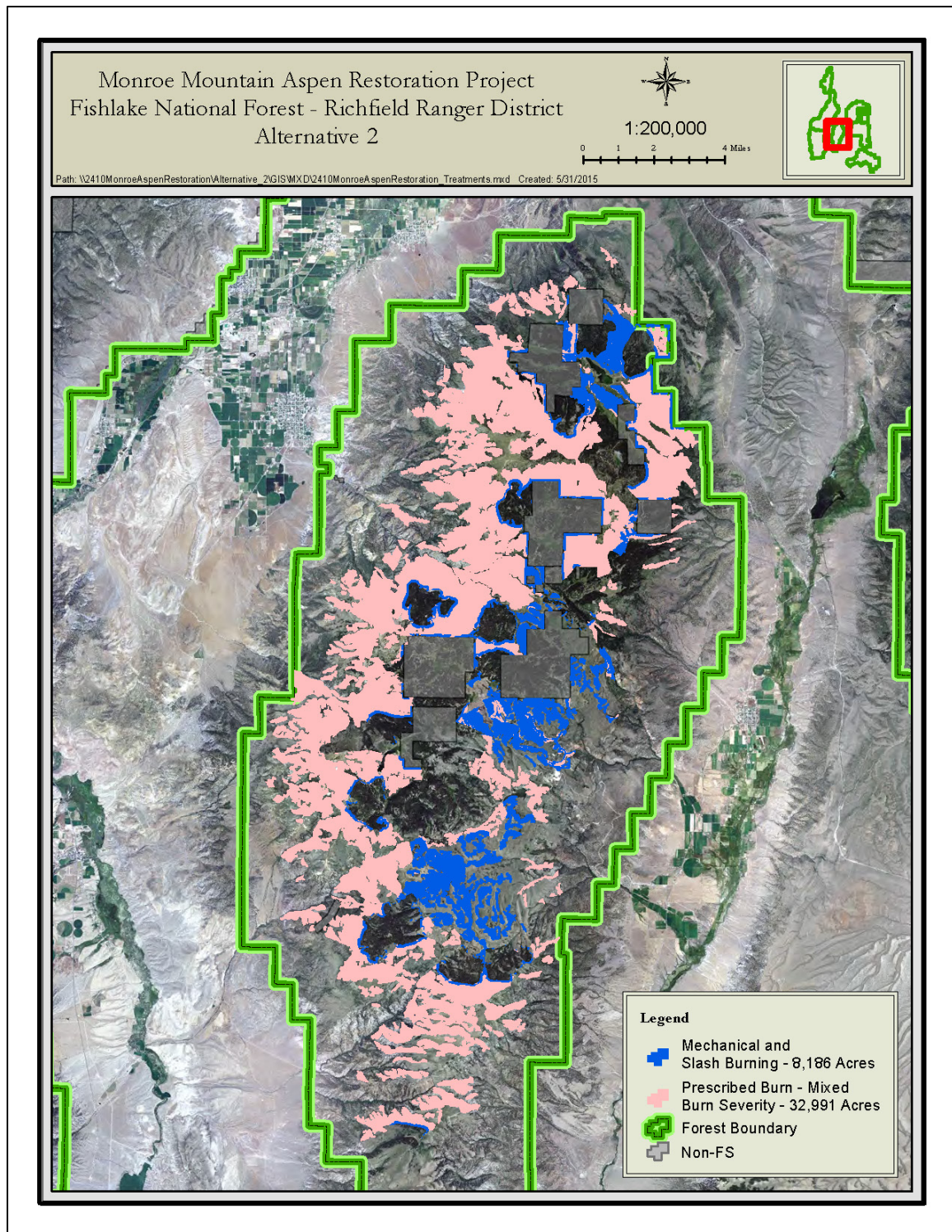


Figure 19: Alternative 2 Proposed Treatment Areas

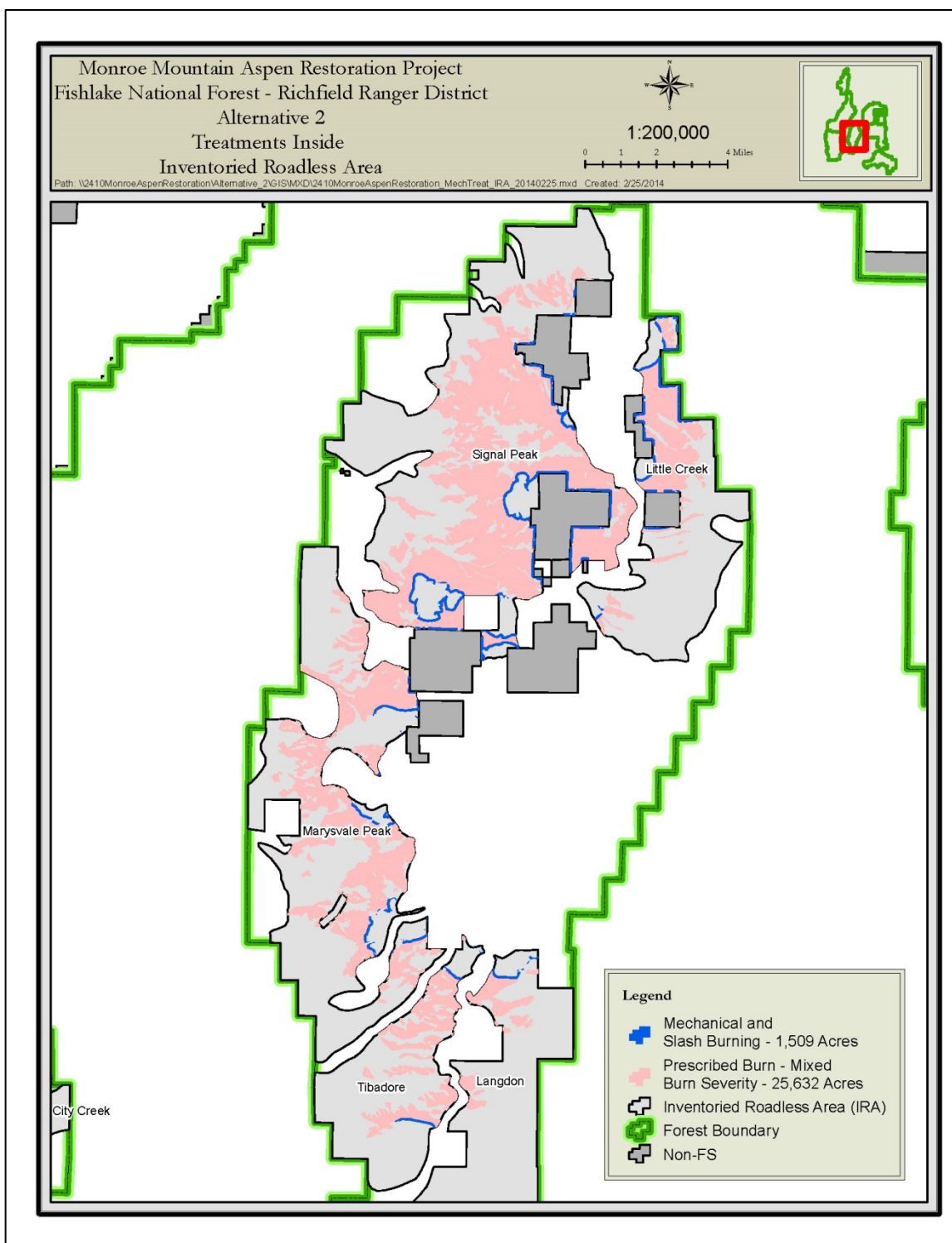


Figure 20: Alternative 2 Proposed Treatments within Inventoried Roadless Areas

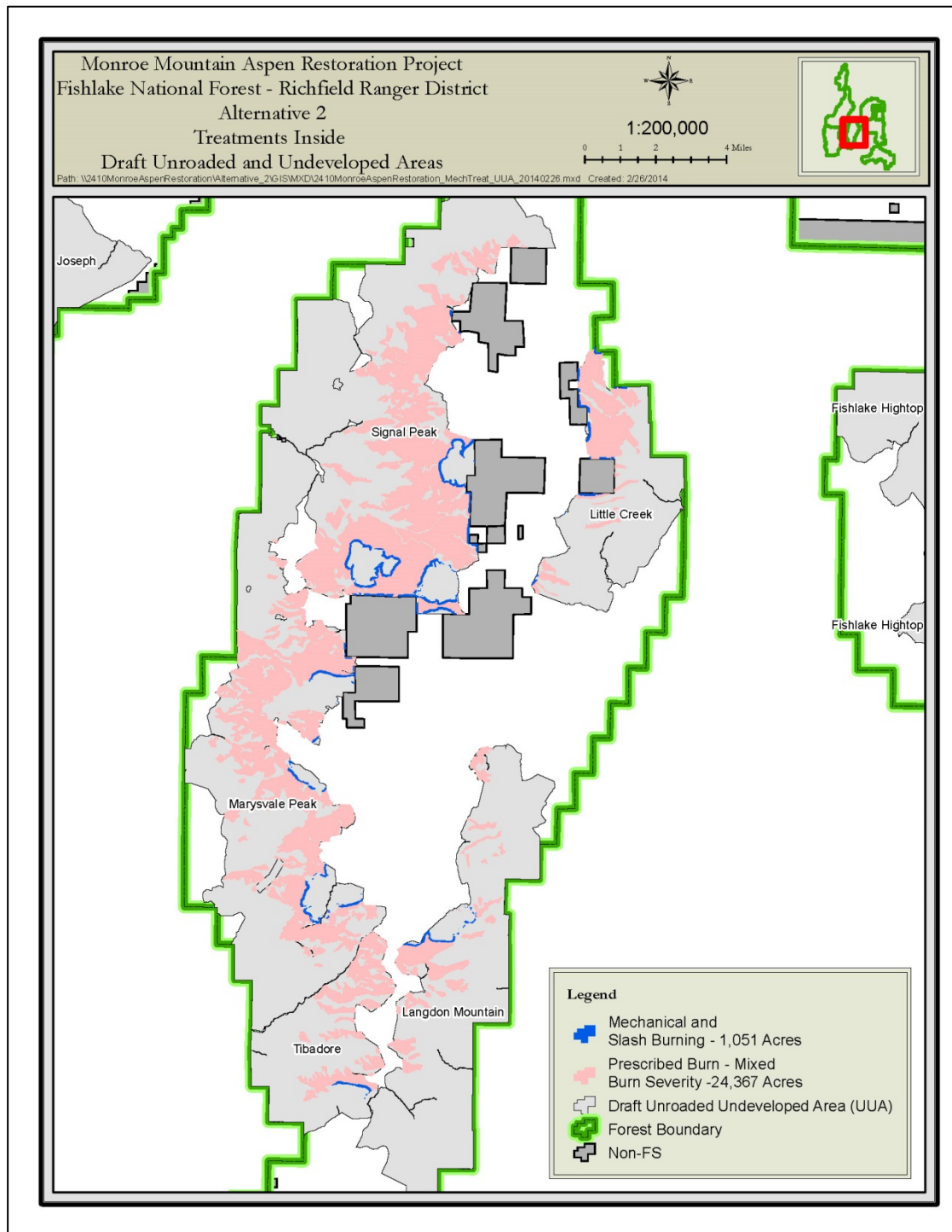


Figure 21: Alternative 2 Proposed Treatments within Draft Unroaded-Undeveloped Areas

Mechanical Treatments and Associated Slash Burning	Prescribed Fire - Mixed Burn Severities	Prescribed Fire – Mixed Burn Severities Factoring 60 percent of the Acres Get Burned	Total Acres	Total Acres Factoring 60 percent of Acres Get Burned	Miles of Temporary Roads
8,186	32,991	19,795	41,177	27,981	8.8

Table 14: Alternative 2 acreage and temporary road mileage

Existing Vegetation	Mechanical and Associated Slash Burning (Acres)	Prescribed Fire Mixed Burn Severities (Acres)	Prescribed Fire - Mixed Burn Severities Factoring 60 percent of the Acres Get Burned
Mixed Conifer	97	4,183	2,510
Seral Aspen	3,146	15,159	9,095
Stable Aspen	4,025	7,991	4,795
Spruce/Fir	918	5,658	3,395
Total	8,186	32,991	19,795

Table 15: Alternative 2 acreage by dominant vegetative type

Alternative 3 (Figure 22)

Seral and Stable Aspen Stands – Proposed Mechanical Treatment Methods

There are two mechanical treatment options being analyzed for Alternative 3 for seral and stable aspen dominated stands (Photos 1 thru 9; Appendix A):

1. Conifers would be removed and the existing aspen would be retained regardless of the size of the conifer or if it is located within an IRA or draft UUA. (Photos 2, 5, and 8; Appendix A; Table 16). To access the conifer, some incidental cutting of aspen may occur. This option would occur throughout the project area.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH and the existing aspen would be retained (Photos 3, 6, and 9; Appendix A; Table 17). In all areas outside the IRAs and draft UUAs, conifers would be removed and the existing aspen would be retained regardless of the size of the conifer.

Spruce/Fir and Mixed Conifer Stands – Proposed Mechanical Treatment Methods

There are also two mechanical treatments options being analyzed for Alternative 3 for spruce/fir and mixed conifer stands (Photos 10 thru 18; Appendix A):

1. This option would occur throughout the project area (Photos 11, 14, and 17; Appendix A; Table 16).
 - a. If present, beetle killed conifer trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (salvage harvest).
 - b. If conifer trees are currently infected by beetles and are in the process of dying, the infected trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (sanitation harvest).
 - c. In areas of spruce/fir or mixed conifer where LRMP stocking levels are below plan guidance due to bark beetle impacts, replanting of spruce or mixed conifer may occur. If the remaining live trees were greater than a BA of 90, the remaining live trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
 - d. If no beetle killed or infected trees are present initially, live trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH (Photos 12, 15, and 18; Appendix A; Table 17). In all areas outside the IRAs and draft UUAs, treatments would occur as in Option 1 for spruce/fir and mixed conifer.

Roads: This alternative proposes to create 8.8 miles of temporary roads for access to mechanical treatment areas (same as Alternative 2).

	Existing Vegetation	Mechanical and Associated Slash Burning
Alternative 3	Seral Aspen	6,422
	Stable Aspen	4,780
	Spruce-Fir	2,355
	Mixed Conifer	91
	Total	13,648

Table 16: Alternative 3; Option 1--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

	Existing Vegetation	Mechanical and Associated Slash Burning (Acres Outside IRAs and UUAs)	Mechanical and Associated Slash Burning (Acres Inside IRAs and UUAs)	Project Total
Alternative 3	Seral Aspen	3,111	3,311	6,422
	Stable Aspen	3,965	815	4,780
	Spruce-Fir	835	1,520	2,355
	Mixed Conifer	90	1	91
	Total	8,001	5,647	13,648

Table 17: Alternative 3; Option 2--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

Issue 2 – Prescribed fire activities may affect adjacent private property

The IRAs (Figure 23) and Draft UUAs (Figure 24) adjacent to private property would have a wider mechanical treatment buffer than Alternative 2 at approximately 0.5 mile wide. This wider buffer of mechanical treatments would be completed first in preparation for being able to implement prescribed fire on National Forest Lands while minimizing impacts to private property. The mechanical treatment buffers for this alternative were developed using topography (slope, ridgetops, drainage bottoms, etc.), natural fuel breaks, previous treatment areas and wildland fires, existing roads and trails, etc.

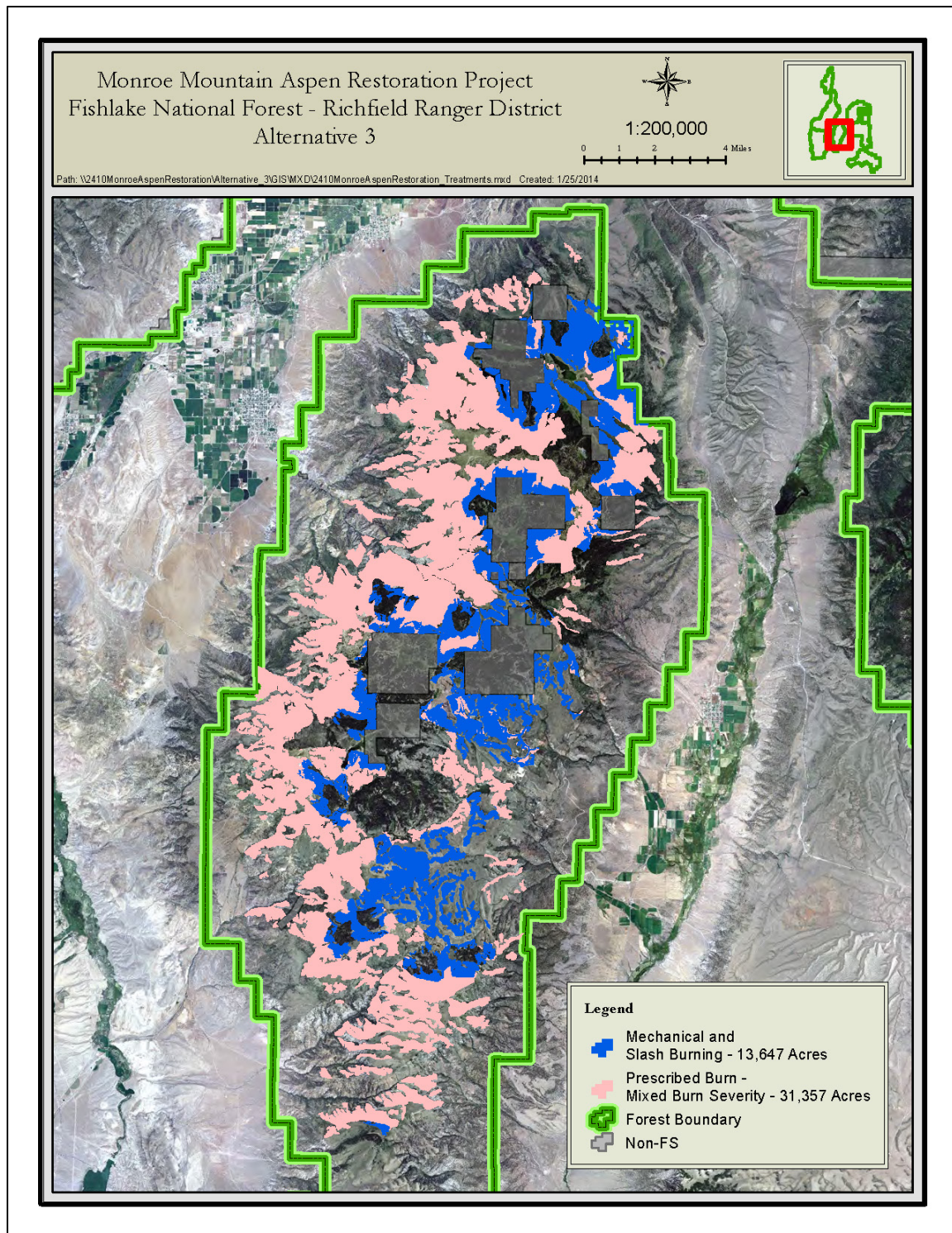


Figure 22: Alternative 3 Proposed Treatment Areas

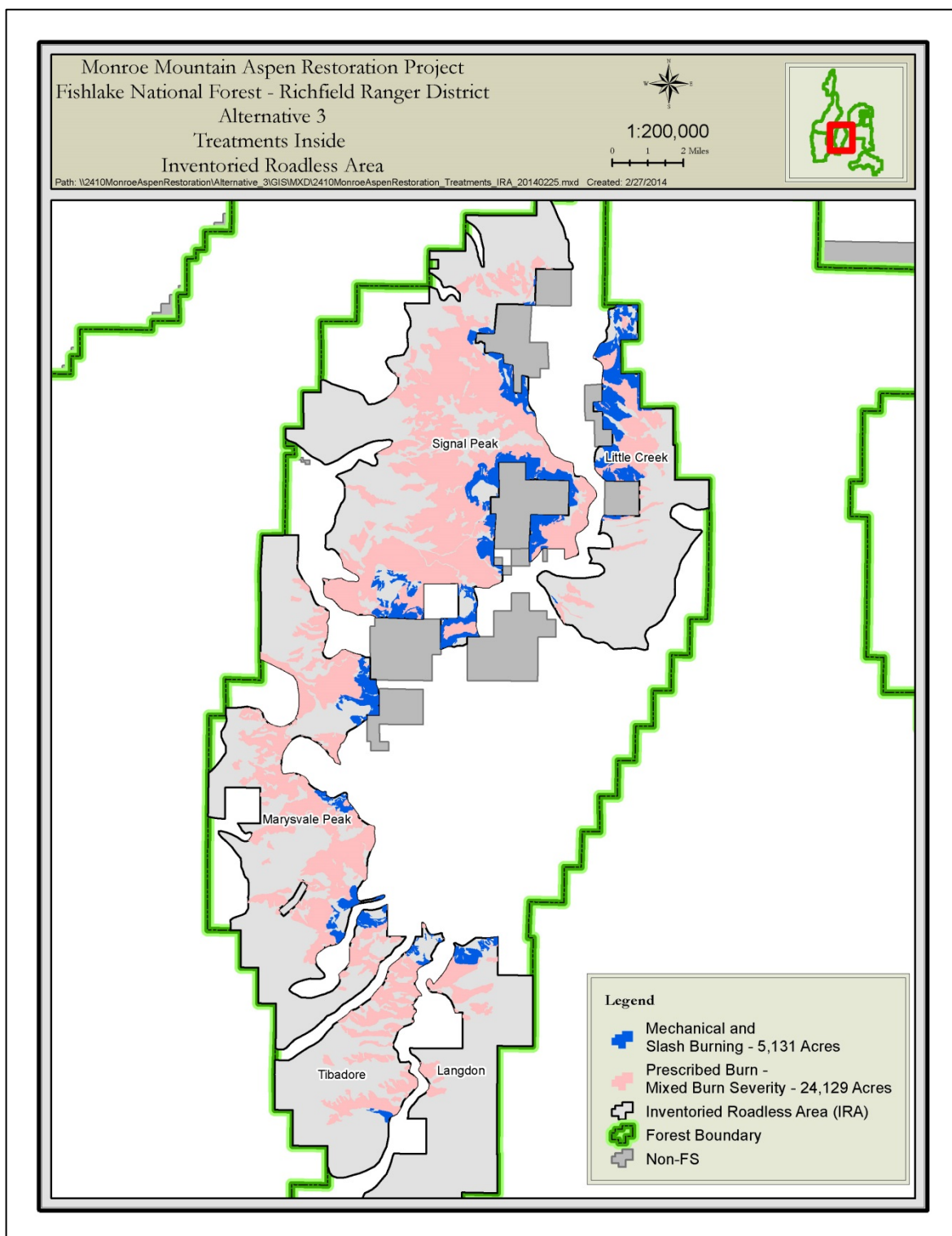


Figure 23: Alternative 3 Proposed Treatments within Inventoried Roadless Areas

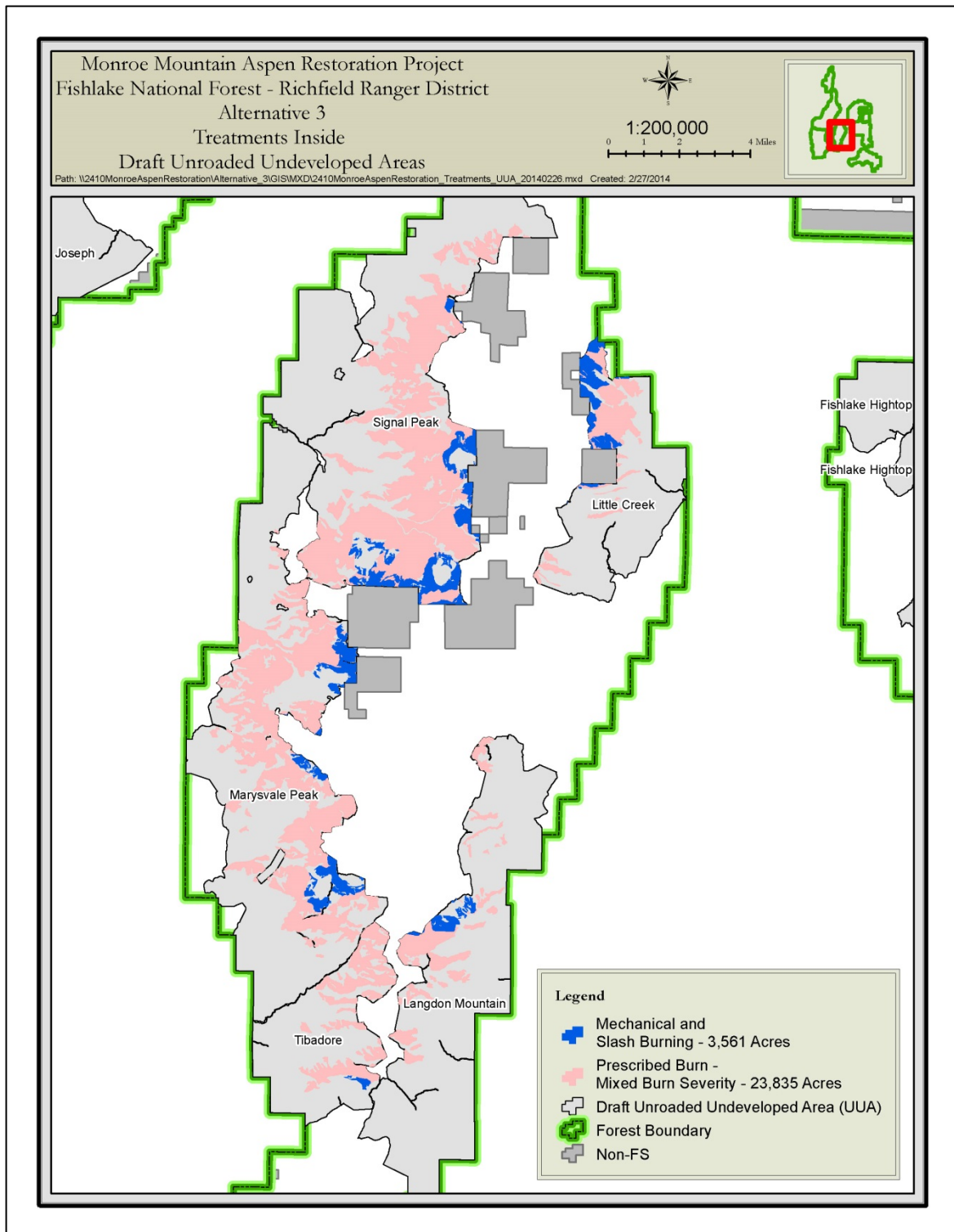


Figure 24: Alternative 3 Proposed Treatments within Draft Unroaded-Undeveloped Areas

Mechanical Treatments and Associated Slash Burning	Prescribed Fire - Mixed Burn Severities	Prescribed Fire – Mixed Burn Severities Factoring 60 percent of the Acres Get Burned	Total Acres	Total Acres Factoring 60 percent of Acres Get Burned	Miles of Temporary Roads
13,648	31,357	18,814	45,004	32,461	8.8

Table 18: Alternative 3 acreage and temporary road mileage

Existing Vegetation	Mechanical and Associated Slash Burning (Acres)	Prescribed Fire Mixed Burn Severities (Acres)	Prescribed Fire - Mixed Burn Severities Factoring 60 percent of the Acres Get Burned
Mixed Conifer	91	4,190	2,514
Seral Aspen	6,422	14,318	8,591
Stable Aspen	4,780	7,861	4,717
Spruce/Fir	2,355	4,988	2,993
Total	13,648	31,357	18,814

Table 19: Alternative 3 acreage by dominant vegetative type

Alternative 4 (Figure 25)

Seral and Stable Aspen Stands – Proposed Mechanical Treatment Methods

There are two mechanical treatment options being analyzed for Alternative 4 for seral and stable aspen dominated stands (Photos 1 thru 9; Appendix A):

1. Conifers would be removed and the existing aspen would be retained regardless of the size of the conifer or if it is located within an IRA or draft UUA. (Photos 2, 5, and 8; Appendix A; Table 20). To access the conifer, some incidental cutting of aspen may occur. This option would occur throughout the project area.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH and the existing aspen would be retained (Photos 3, 6, and 9; Appendix A; Table 21). In all areas outside the IRAs and draft UUAs, conifers would be removed and the existing aspen would be retained regardless of the size of the conifer.

Spruce/Fir and Mixed Conifer Stands – Proposed Mechanical Treatment Methods

There are also two mechanical treatments options being analyzed for Alternative 4 for spruce/fir and mixed conifer dominated stands (Photos 10 thru 18; Appendix A):

1. This option would occur throughout the project area (Photos 11, 14, and 17; Appendix A; Table 20).
 - a. If present, beetle killed conifer trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (salvage harvest).
 - b. If conifer trees are currently infected by beetles and are in the process of dying, the infected trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (sanitation harvest).
 - c. In areas of spruce/fir or mixed conifer where LRMP stocking levels are below plan guidance due to bark beetle impacts, replanting of spruce or mixed conifer may occur. If the remaining live trees were greater than a BA of 90, the remaining live trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
 - d. If no beetle killed or infected trees are present initially, live trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH (Photos 12, 15, and 18; Appendix A; Table 21). In all areas outside the IRAs and draft UUAs, treatments would occur as in option 1 for spruce/fir and mixed conifer.

Roads: This alternative proposes to create 13.3 miles of temporary roads for access to mechanical treatment areas; 0.3 miles of these roads are proposed within the draft UUAs (Figure 27).

	Existing Vegetation	Mechanical and Associated Slash Burning
Alternative 4	Seral Aspen	9,492
	Stable Aspen	6,130
	Spruce-Fir	4,113
	Mixed Conifer	102
	Total	19,837

Table 20: Alternative 4; Option 1--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

	Existing Vegetation	Mechanical and Associated Slash Burning (Acres Outside IRAs and UUAs)	Mechanical and Associated Slash Burning (Acres Inside IRAs and UUAs)	Project Total
Alternative 4	Seral Aspen	3,991	5,501	9,492
	Stable Aspen	4,196	1,934	6,130
	Spruce-Fir	1,186	2,927	4,113
	Mixed Conifer	91	11	102
	Total	9,464	10,373	19,837

Table 21: Alternative 4; Option 2--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

Issue 2 – Prescribed fire activities may affect adjacent private property

The IRAs (Figure 26) and Draft UUAs (Figure 27) adjacent to private property would have a wider mechanical treatment buffer than Alternatives 2 and 3, but similar to Alternative 5 at approximately 1.3 miles wide. This wider buffer of mechanical treatments would be completed first in preparation for being able effectively implement prescribed fire on National Forest Lands while minimizing impacts to private property. The mechanical treatment buffers for this alternative were developed using topography (slope, ridgetops, drainage bottoms, etc.), natural fuel breaks, previous treatment areas and wildland fires, existing roads and trails, etc.

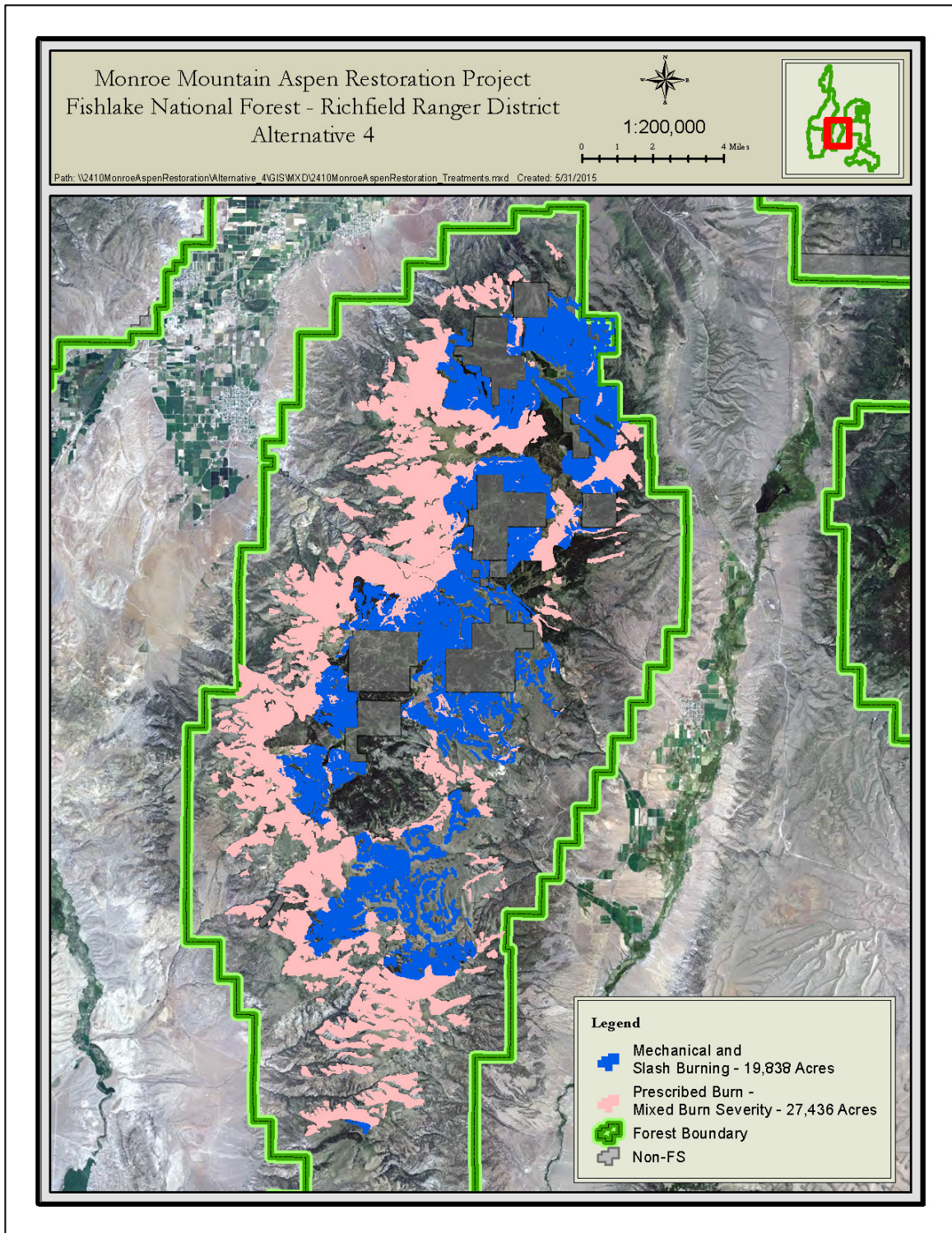


Figure 25: Alternative 4 Proposed Treatment Areas

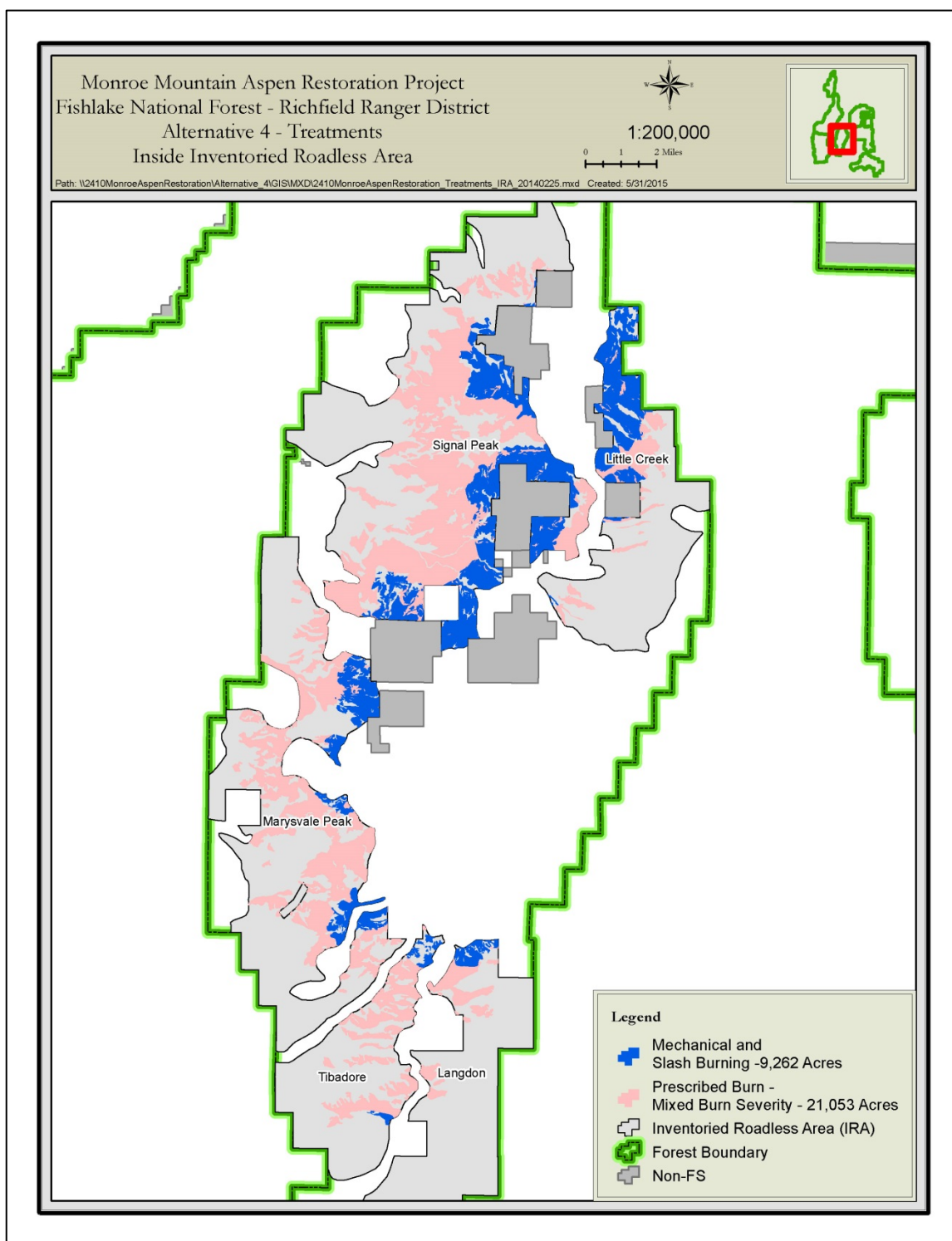


Figure 26: Alternative 4 Proposed Treatments within Inventoried Roadless Areas

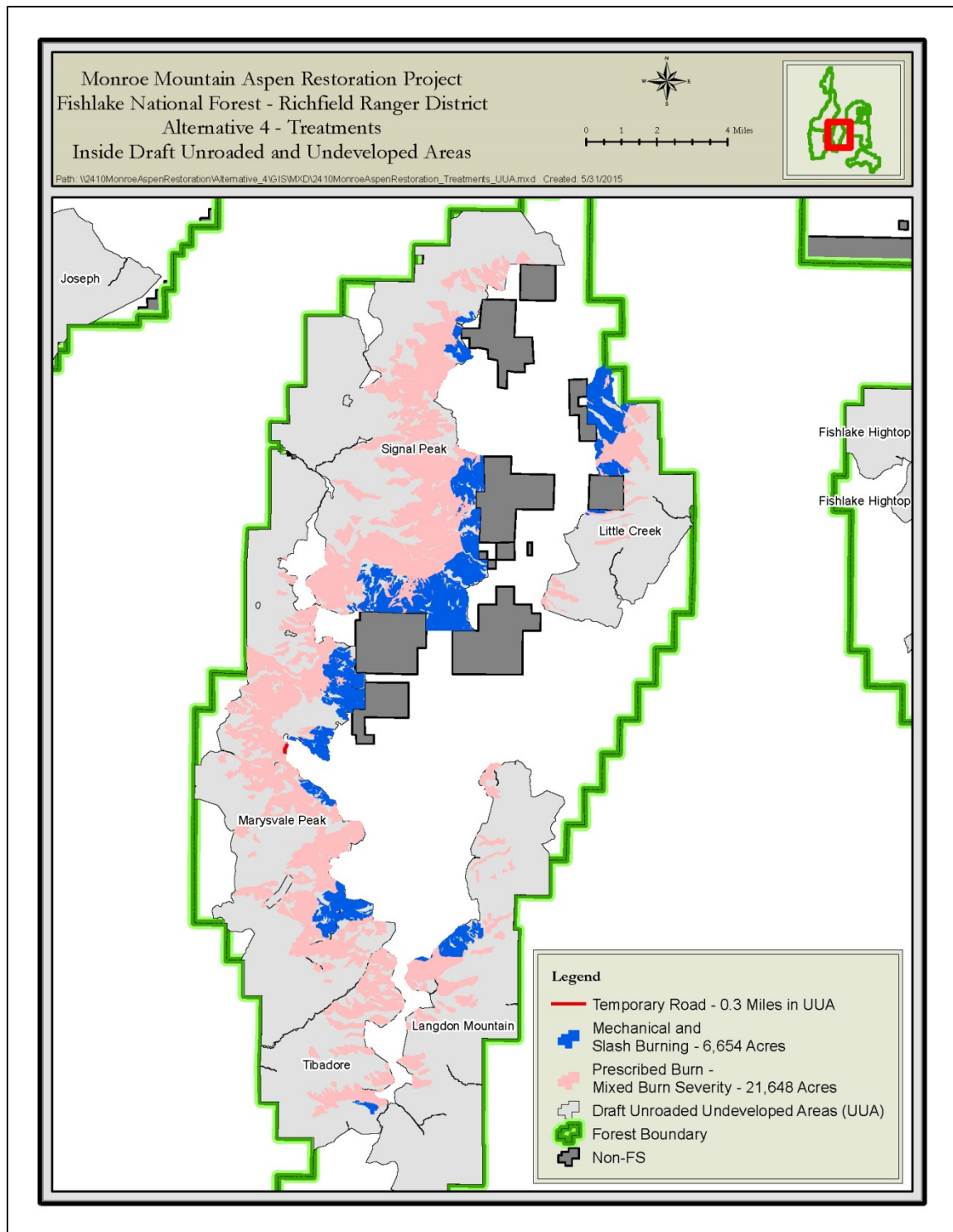


Figure 27: Alternative 4 Proposed Treatments within Draft Unroaded-Undeveloped Areas with Associated Temporary Roads

Mechanical Treatments and Associated Slash Burning	Prescribed Fire - Mixed Burn Severities	Prescribed Fire – Mixed Burn Severities Factoring 60% of the Acres Get Burned	Total Acres	Total Acres Factoring 60% of Acres Get Burned	Miles of Temporary Roads
19,837	27,436	16,462	47,274	36,300	13.3

Table 22: Alternative 4 acreage and temporary road mileage

Existing Vegetation	Mechanical and Associated Slash Burning (Acres)	Prescribed Fire Mixed Burn Severities (Acres)	Prescribed Fire - Mixed Burn Severities Factoring 60% of the Acres Get Burned
Mixed Conifer	102	4,178	2,507
Seral Aspen	9,492	12,763	7,658
Stable Aspen	6,130	6,693	4,016
Spruce/Fir	4,113	3,802	2,281
Total	19,837	27,436	16,462

Table 23: Alternative 4 acreage by dominant vegetative type

Alternative 5 (Figure 28)

Seral and Stable Aspen Stands – Proposed Mechanical Treatment Methods

There are two mechanical treatment options being analyzed for Alternative 5 for seral and stable aspen dominated stands (Photos 1 thru 9; Appendix A):

1. Conifers would be removed and the existing aspen would be retained regardless of the size of the conifer or if it is located within an IRA or draft UUA. (Photos 2, 5, and 8; Appendix A; Table 24). To access the conifer, some incidental cutting of aspen may occur. This option would occur throughout the project area.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH and the existing aspen would be retained (Photos 3, 6, and 9; Appendix A; Table 25). In all areas outside the IRAs and draft UUAs, conifers would be removed and the existing aspen would be retained regardless of the size of the conifer.

Spruce/Fir and Mixed Conifer Stands – Proposed Mechanical Treatment Methods

There are also two mechanical treatments options being analyzed for Alternative 5 for spruce/fir and mixed conifer dominated stands (Photos 10 thru 18; Appendix A):

1. This option would occur throughout the project area (Photos 11, 14, and 17; Appendix A; Table 24).
 - a. If present, beetle killed conifer trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (salvage harvest).
 - b. If conifer trees are currently infected by beetles and are in the process of dying, the infected trees would be removed while ensuring consistency with the LRMP for snags and down woody debris (sanitation harvest).
 - c. In areas of spruce/fir or mixed conifer where LRMP stocking levels are below plan guidance due to bark beetle impacts, replanting of spruce or mixed conifer may occur. If the remaining live trees were greater than a BA of 90, the remaining live trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
 - d. If no beetle killed or infected trees are present initially, live trees would be thinned using uneven aged management to a BA of 90 with single and group tree selection.
2. Within IRAs and draft UUAs, conifer would be thinned from below up to 8 inch DBH (Photos 12, 15, and 18; Appendix A; Table 25). In all areas outside the IRAs and draft UUAs, treatments would occur as in Option 1 for spruce/fir and mixed conifer.

Roads: This alternative proposes to create 12.8 miles of temporary roads for access to treatment areas; 1.3 miles of roads are proposed within draft UUAs (Figure 30).

	Existing Vegetation	Mechanical and Associated Slash Burning
Alternative 5	Seral Aspen	6,736
	Stable Aspen	5,340
	Spruce-Fir	2,905
	Mixed Conifer	91
	Total	15,072

Table 24: Alternative 5; Option 1--Mechanical treatments with associated slash burning for seral and stable aspen, spruce/fir, and mixed conifer dominated stands

	Existing Vegetation	Mechanical and Associated Slash Burning (Acres Outside IRAs and UUAs)	Mechanical and Associated Slash Burning (Acres Inside IRAs and UUAs)	Project Total
Alternative 5	Seral Aspen	2,547	4,189	6,736
	Stable Aspen	3,830	1,510	5,340
	Spruce-Fir	984	1,921	2,905
	Mixed Conifer	90	1	91
	Total	7,451	7,621	15,072

Table 25: Alternative 5; Option 2--Mechanical treatments with associated slash burning for seral and stable aspen, spruce-fir, and mixed conifer dominated stands

Issue 2 – Prescribed fire activities may affect adjacent private property

The IRAs (Figure 29) and Draft UUAs (Figure 30) adjacent to private property would have a more similar mechanical treatment buffer to Alternatives 3 & 4 with variations occurring where Northern goshawk PFAs and NAs occur adjacent to private property. The buffer adjacent to private property would be wider than Alternatives 2 and 3, and similar to Alternative 4 at approximately 1.3 miles wide. Where Northern goshawk PFAs and NAs occur, the mechanical treatment buffers mostly occur along the outside edge of the PFAs (the exception being with two of the PFAs located adjacent to private property that are proposed for treatment; no NAs would be treated) (Figure 28). This buffer of mechanical treatment would be completed first in preparation for being able to implement prescribed fire on National Forest Lands while minimizing impacts to private property and Northern goshawk areas. The mechanical treatment buffers for this alternative were developed using topography (slope, ridgetops, drainage bottoms, etc.), natural fuel breaks, previous treatment areas and wildland fires, existing roads and trails, etc.

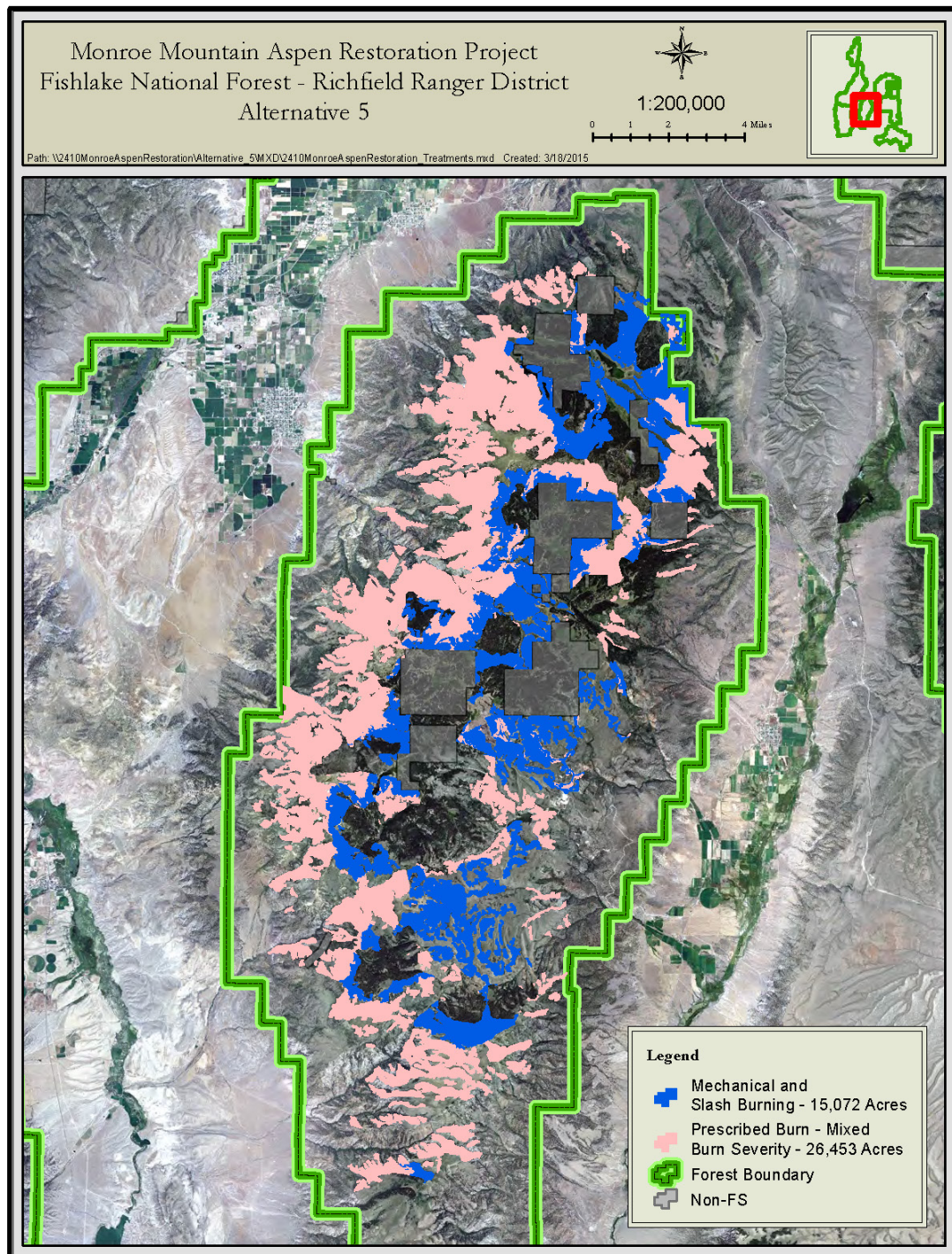


Figure 28: Alternative 5 Proposed Treatment Areas

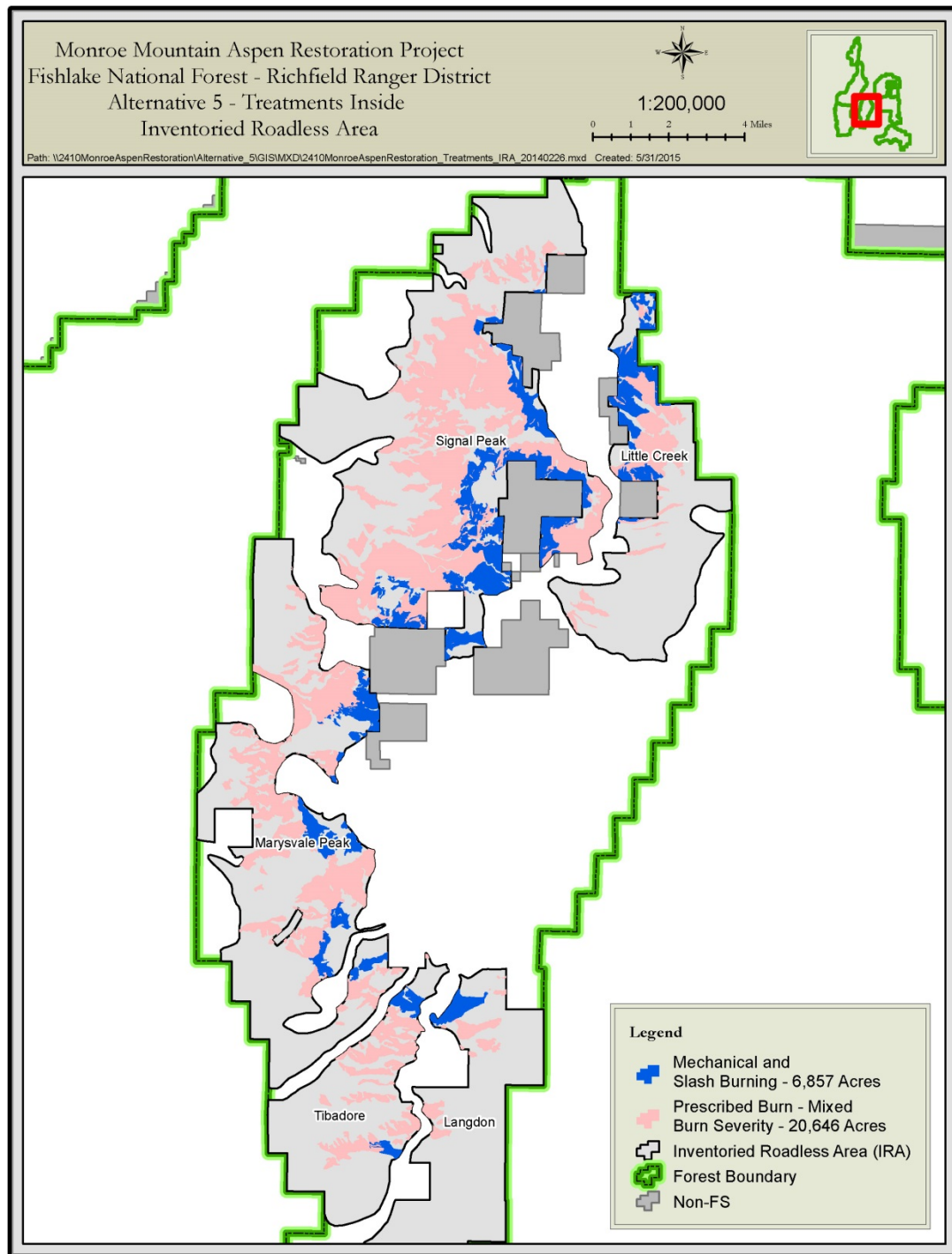


Figure 29: Alternative 5 Proposed Treatments within Inventoried Roadless Areas

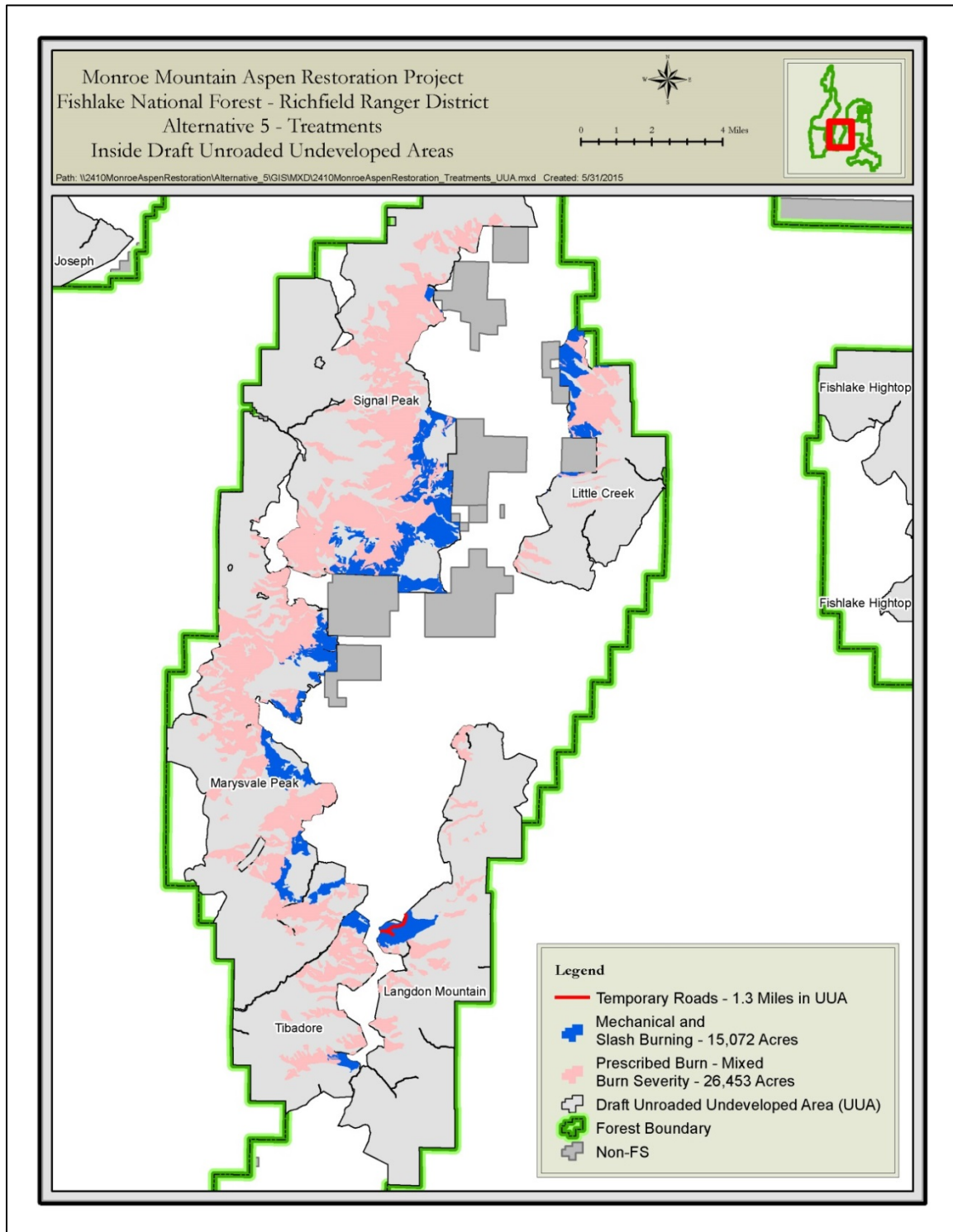


Figure 30: Alternative 5 Proposed Treatments within Draft Unroaded-Undeveloped Areas with Associated Temporary Roads

Mechanical Treatments and Associated Slash Burning	Prescribed Fire - Mixed Burn Severities	Prescribed Fire – Mixed Burn Severities Factoring 60% of the Acres Get Burned	Total Acres	Total Acres Factoring 60% of Acres Get Burned	Miles of Temporary Roads
15,072	26,453	15,872	41,525	30,944	12.8

Table 26: Alternative 5 acreage and temporary road mileage

Existing Vegetation	Mechanical and Associated Slash Burning (Acres)	Prescribed Fire Mixed Burn Severities (Acres)	Prescribed Fire - Mixed Burn Severities Factoring 60% of the Acres Get Burned
Mixed Conifer	91	4,190	2,514
Seral Aspen	6,736	11,676	7,006
Stable Aspen	5,340	6,777	4,066
Spruce/Fir	2,905	3,810	2,286
Total	15,072	26,453	15,872

Table 27: Alternative 5 acreage by dominant vegetative type

Alternatives 2-5

Direct and Indirect Effects common to all proposed prescribed fire treatments in all Action Alternatives

Fire is a natural process that the aspen/mixed conifer and aspen/spruce fir ecosystems evolved with, as did many other vegetative systems on Monroe Mountain. Fires will continue to occur. Prescribed fires and fires managed for multiple objectives are likely to produce beneficial post-fire effects in the fire-adapted ecosystems. Most fire effects cannot be created by a treatment other than fire. These effects include nutrient cycling, seed scarification (by both heat and smoke) promoting a vegetative mosaic of seedlings, suckers, shrubs, forbs and grasses, regulating available fuel loads, changes in soil moisture, etc. The many benefits of mechanical treatments coupled with prescribed fire include a controlled reduction in surface and canopy fuels which is especially needed in the project area near private lands. The effects of the Action Alternatives differ primarily in the magnitude of the treatments which are disclosed in Table 28.

	Mechanical Treatments and Associated Slash Burning	Prescribed Fire - Mixed Burn Severities	Prescribed Fire – Mixed Burn Severities Factoring 60% of the Acres Get Burned	Total Acres	Total Acres Factoring 60% of Acres Get Burned	Miles of Temporary Roads
Alternative 1	0	0	0	0	0	0
Alternative 2	8,186	32,991	19,795	41,177	27,981	8.8
Alternative 3	13,647	31,357	18,814	45,004	32,461	8.8
Alternative 4	19,838	27,436	16,462	47,274	36,300	13.3
Alternative 5	15,072	26,453	15,872	41,525	30,944	12.8

Table 28: Summary of Alternatives 1-5.

The risk of large, unmitigated wildfire would be reduced through all the Action Alternatives, although some treatments would better create safer work places for fire fighters and prescribed fire managers to work as the project progresses. The treatments assessed would not fireproof the Project Area; instead they would reduce the amount of fuels near private lands, leading to reduced fire behavior. Reduced fire behavior (flame lengths below 4 feet, reduced spotting and less crown fire initiation) creates a safer place for wildland firefighters and prescribed fire crews to work in both the short and long term.

Stable aspen stands are known to slow and/or stop a fire on the Fishlake National Forest during many fire seasons. On the adjacent Beaver District, Fishlake National Forest, there are more than 100,000 acres of mixed-conifer/aspen ecosystems. A variety of treatments causing dominant aspen units occurred in this area including the Grindstone Flat clearcut and exclosure study in 1934, the Betenson Mill wildfire in 1958, and the Betenson Flat spruce harvest in 1972. These treatments gave rise to vigorous young stands of quaking aspen (*Populus tremuloides*).

All of these treatments were in the path of the Pole Creek wildfire that burned through the area in 1996 and scorched about 10,400 acres. The Pole Creek fire burned around these aspen stands that were about 20, 40, and 60 years old respectively. All were effective firebreaks during the 1996 wildfire. This is a landscape-scale example showing that young aspen stands can be effective firebreaks for at least 60 years, once established and recruitment has occurred (Campbell, Bartos, et.al, 2004).

Options 1 and 2 Compared

Options 1 and 2 are not shown separately on maps and charts developed from this fire modeling as the models are too general to differentiate between them and display that. The proposed Option 1 and Option 2 treatments differ in a number of ways that affect fire behavior.

Flame Lengths

Flame lengths outputs from the models used are not different enough to be useful in decision-making.

Spotting

Spotting will be extremely limited in Option 1 in seral and stable aspen stands as only aspen are left, which rarely spot. Mixed conifer and spruce fir under Option 1 post treatment would have a lower average stand height. This lower stand height would reduce spotting distance compared to Option 2. Option 2 would not reduce spotting distance as the stand height would remain the same.

Crown Fire

Opening the overstory up through cutting the stands to a 90 basal area, as in Option 1, will have an impact on crown fire initiation. Small clumps of trees may still be able to torch, and a running crown fire would be unsustainable in a crown which had been partially cut out. This lowers the threat of crown fire impacting private lands and lowers the risk to firefighters working there. There are more trees per acre greater than 8" dbh in Option 2 in IRA/UUA areas. This means that more continuous aerial fuel is available to carry a crown fire through it if a crown fire hits it than the discontinuous crown fuels created in Option 1.

Option 2: Thinning a stand from below reduces primarily surface and some ladder fuels. The majority of the crown fuels, both conifer and aspen remain as if untreated. When a crown fire moves into the thinned from below stands, it is possible that it could sustain itself across those stands and into the next, resulting in a fire crossing onto private lands. Until the prescribed burning was completed (up to 10 years) the private lands would be likely to have crown fire from a wildfire cross onto them. Once the prescribed fires were completed, the private lands would be at a lower risk.

On stable aspen sites it is unusual to have enough ladder fuel to cause much torching and crown fires are unlikely due to aspen's typical high fuel moisture. In fact, aspen is often used as a safety zone by firefighters as the typical vegetation has higher fuel moisture than surrounding vegetation communities. Aspen communities are also often used as firebreaks when burning surrounding vegetation (Hood and Miller, eds. 2007). Autumn leaf fall can carry a surface fire and frequent fires can maintain a grass-forb community, with aspen suckers confined to the shrub layer. Fire behavior is often so low that aerial ignition is recommended in the sparse fuels of an aspen forest to create enough preheating to move a fire across the fuels (Brown and Simmerman, 1986).

Treatment Length

The effective lengths of the impacts from fuels treatment on fire behavior are different as well. Option 1, once fully treated, should last without maintenance for more than 20 years as the stands have been opened up and will take years to reach the pre-treatment density. Option 2, once fully treated, will begin to accumulate new fuels immediately from the untouched overstory, contributing to a shorter time between treatments.

Option 1 fuels treatment effects would last without maintenance up to 20 years, based conservatively on the Beaver District Pole Canyon fire effects. Crown fire initiation is a function of basal area, crown base height and trees per acre. Indirect effects include a longer estimated retreatment time when compared with Option 2.

Option 2 will likely need to be retreated in 10 years, leading to twice the treatment cost over the length of the project and into the future. Indirectly, the estimated retreatment time on Option 2 would be at least double that of Option 1, then it would likely need to be thinned again to keep it open enough to use as a shaded fuel break.

Immediately following treatments surface flame lengths would be similar as leftover fuels in both treatments would be piled and burned. Over time, it is likely that Option 2 will recruit dead and down fuels faster due to the denser overstory, standing trees dying and falling and dead branch wood. Option 1 is likely to result in lower overall fire behavior than Option 2.

Flame Lengths

Flame length fire modeling results are shown after the mechanical treatments are done and piles are burned for each alternative proposed.

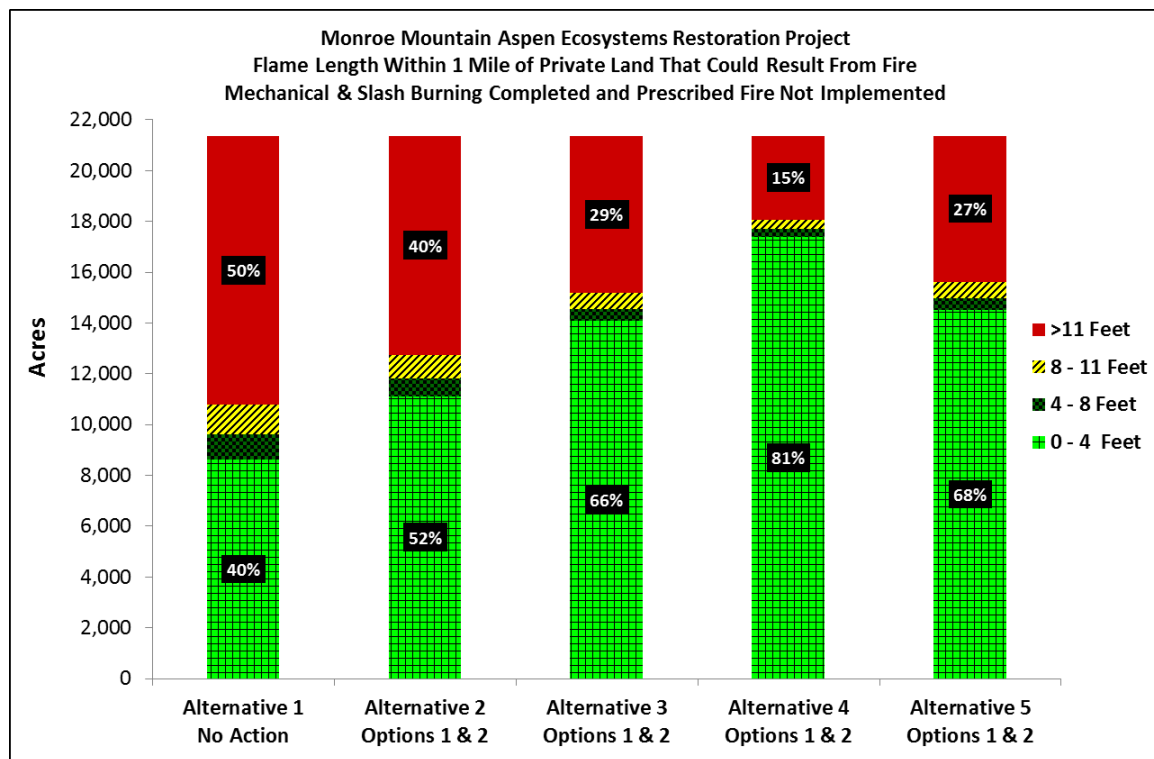


Figure 31: Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length. Options 1 & 2 - Proposed Treatment Areas within 1 Mile of Private Land. Mechanical & Slash Burning Completed and Prescribed Fire Not Implemented.

The graph above shows the flame length differences among the No Action and Action Alternatives for Options 1 and 2 within 1 mile of private land.

Under no action, 60% of the acreage can produce flame lengths of more than four feet. Remember that flame lengths greater than four feet are unsafe to have firefighter's direct attack safely. Any of the action alternatives increase the number of acres that are considered safe to initial attack.

Compared to the No Action Alternative which has 60% of the flame lengths above 4 feet, Alternative 2 has 48% of the acreage exhibiting flame lengths above four feet which is less than the 60%. Within the IRAs/UUAs the majority of the acreage exhibiting flame lengths of more than 4 feet occurs 300 feet or more from private property. These narrow fuel buffer changes will have a direct effect on whether or not the subsequent prescribed fires are completed. Where slopes are steep and fuel mitigation is narrow, it is unlikely that prescribed fires will be lit in a timely manner to conclude the project in 10 years. Ignition windows are limited by current weather and fuel dryness, expected fire behavior and expected weather. There may be few days a year that a prescribed fire can be lit and concluded with success with the proposed fuel changes as ignition/holding barriers. The adjoining wildland fuels are likely to burn much more actively.

Alternative 3 shows 34% of the acreage exhibiting flame lengths above four feet. Within the IRAs/UUAs the majority of the acreage exhibiting flame lengths of more than 4 feet occurs a half mile or more from private property.

Alternative 4 shows 19% of the acreage exhibiting flame lengths above four feet. Within the IRAs/UUAs the majority of the acreage exhibiting flame lengths of more than 4 feet occurs 1.3 miles or more from private property.

Alternative 5 shows 32% of the acreage exhibiting flame lengths above four feet. Within the IRAs/UUAs the majority of the acreage exhibiting flame lengths of more than 4 feet occurs 1.3 miles or more from private property.

Summary: At this interim stage of the project, Alternative 4 best reduces flame lengths compared to the No Action Alternative. This results in the most acres exhibiting flame lengths less than 4 feet which creates a safer situation to ignite prescribed fires to complete the proposed actions with lower risk to private lands (Issue 2). The lower flame lengths lead to fewer embers lofted which results in fewer spot fires. This also minimizes potential fire impacts to private lands better than the other alternatives.

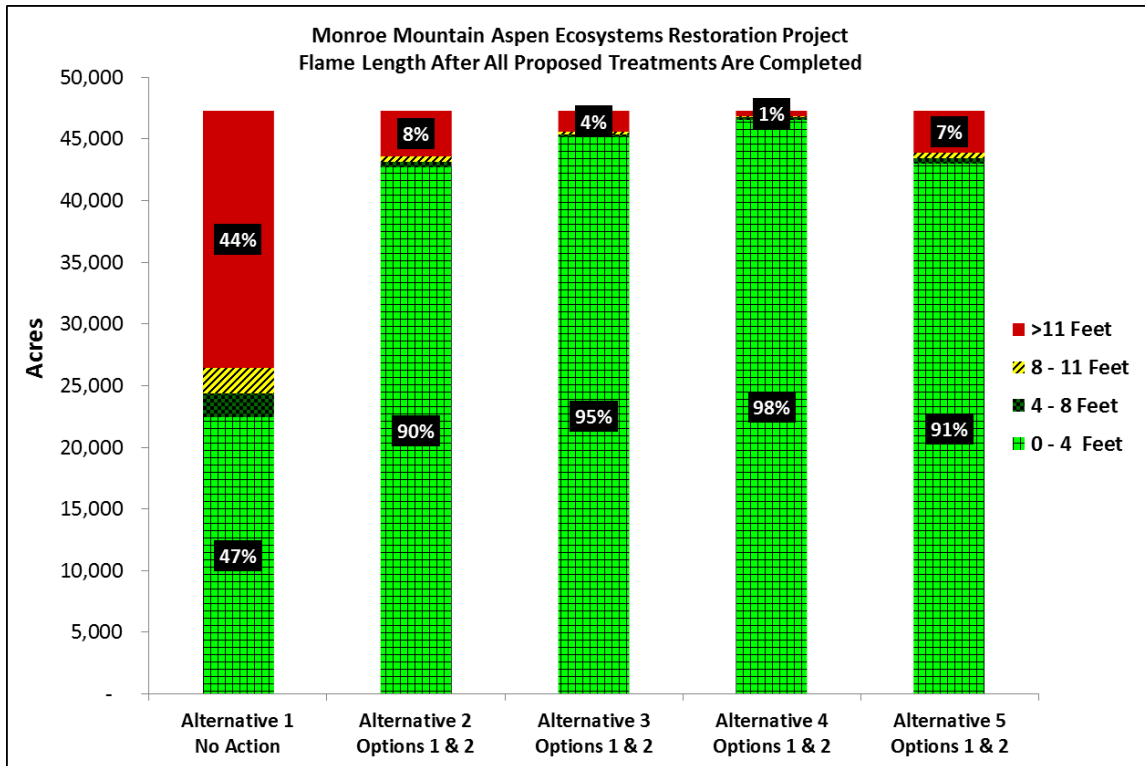


Figure 32: Monroe Mountain Aspen Ecosystems Restoration Project Flame Length After All Proposed Treatments Are Completed.

The No Action Alternative leaves 53% of the area with flame lengths above 4 feet. After all treatments are completed, all action alternatives are an improvement over the No Action. In terms of flame lengths, Alternatives 2 and 5 are similar post-treatment, leaving 10% and 9% respectively above 4 foot flame lengths. Alternative 3 causes 95% of the area to exhibit flame lengths below 4 feet. Alternative 4 performs best, causing 98% of treated area to exhibit flame lengths below 4 feet.

Spotting

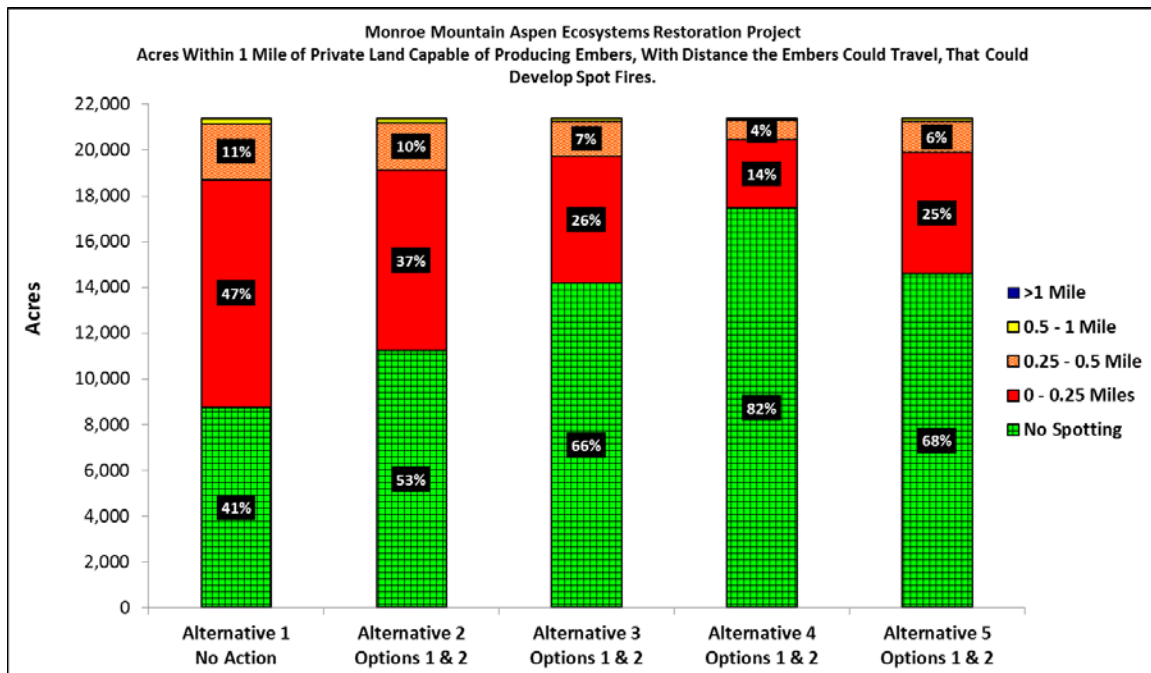


Figure 33: Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Distance. Options 1 & 2 - Proposed Treatment Areas within 1 Mile of Private Land. Mechanical & Slash Burning Completed and Prescribed Fire Not Implemented.

The graph above shows the spotting distance differences among the No Action and Action Alternatives.

Under no action 59% of the acreage can produce spots. All of the action alternatives decrease the number of acres that can produce spots. Alternative 2 reduces overall spotting acres from 59% to 47%, Alternative 3 reduces overall spotting to 34% compared to 59% (No Action). Alternative 4 reduces overall spotting to 18% compared to 59% (No Action). Alternative 5 reduces overall spotting to 32% compared to 59% (No Action).

Alternative 2 reduces 0.0-0.25 mile spotting from 47% to 37% compared to No Action. Alternative 3 reduces 0.0-0.25 mile spotting from 47% to 26% compared to No Action. Alternative 5 reduces 0.0-0.25 mile spotting from 47% to 14% compared to No Action. Alternative 5 reduces 0.0-0.25 mile spotting from 47% to 25% compared to No Action.

Alternative 2 reduces 0.25-0.5 mile spotting from 11% to 10% compared to No Action. Alternative 3 reduces 0.25-0.5 mile spotting from 11% to 7% compared to No Action. Alternative 4 reduces 0.25-0.5 mile spotting from 11% to 4% compared to No Action. Alternative 5 reduces 0.25-0.5 mile spotting from 11% to 6% compared to No Action.

A similar pattern in reduction of acreage which can create spots follows for further spotting distances. Alternative 4 is likely to produce the fewest acres that can produce embers that can cause spot fires, minimizing impact to private land the best.

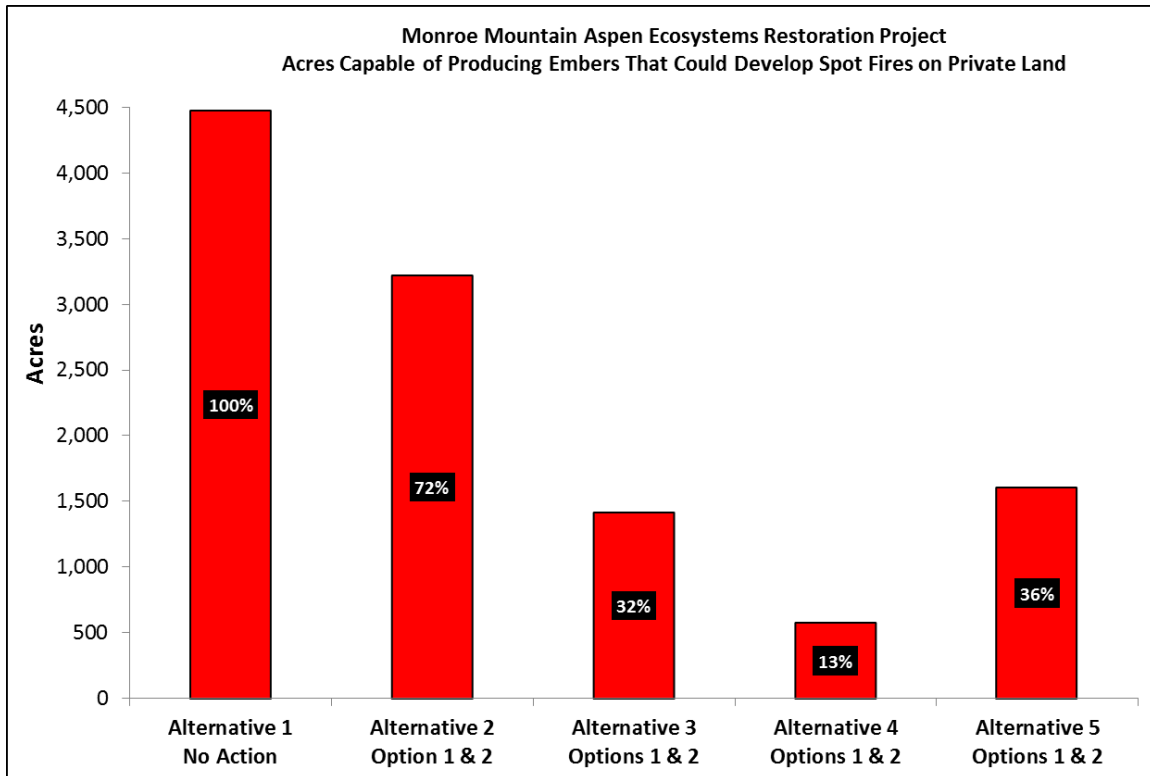


Figure 34: Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Capable of Producing Embers That Could Develop Spot Fires on Private Land. Mechanical & Slash Burning Completed and Prescribed Fire Not Implemented.

Figure 34 directly addresses Issue 2 – Prescribed fire activities may affect adjacent private property. It demonstrates that without action, 4,500 acres can produce embers that could cause spot fires on private land. That is, 100% of the spotting produced during a fire can reach private lands. Alternative 2 reduces that to 3,300 acres (72%), Alternative 3 reduces it to 1,400 acres (33%). Alternative 5 reduces it to 1,500 (36%), similar in outcome to Alternative 3. Alternative 4 does the best job of reducing spotting that may reach private lands from fire, reducing the acreage to 500 (13%).

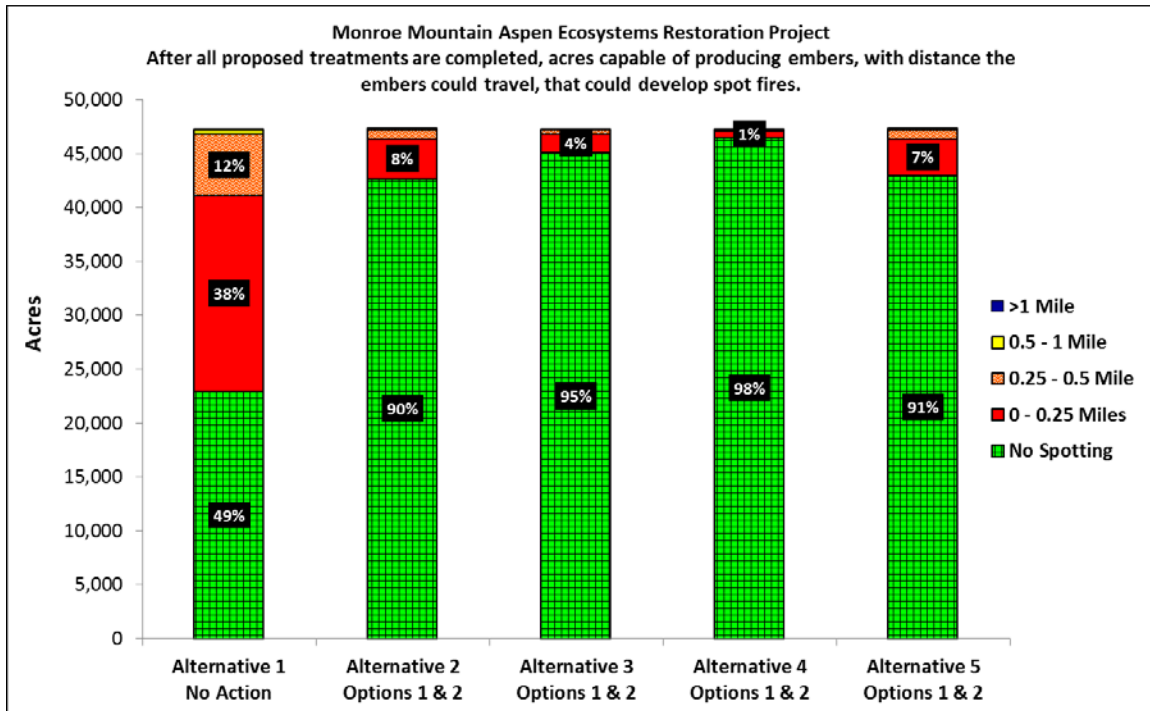


Figure 35: Monroe Mountain Aspen Ecosystems Restoration Project After all proposed treatments are completed, acres capable of producing embers, with distance the embers could travel that could develop spot fires.

With No Action, no spotting occurs from 49% of the area. 38% of the area can produce embers up to ¼ mile, 12 % can produce embers ¼ to ½ mile and 1% can produce embers which can travel up to a mile. All action alternatives greatly lessen the total spotting. Alternative 2 exhibits no spotting over 90% of the area, 8% can produce embers up to ¼ mile and 2 % produces embers which can travel up to a mile. Alternative 3 exhibits no spotting over 95% of the area, 4 % can produce embers up to ¼ mile and 1 % produces embers which can travel up to a mile. Alternative 4 exhibits no spotting over 98% of the area, 1% can produce embers up to ¼ mile and 1 % produces embers which can travel up to a mile. Alternative 5 exhibits no spotting over 91% of the area, 7 % can produce embers up to ¼ mile and 2 % produces embers which can travel up to a mile. Alternative 4 produces the best results for addressing Issue 2 with over 45,000 acres unlikely to produce any spots once all proposed treatments are completed.

Crown Fire

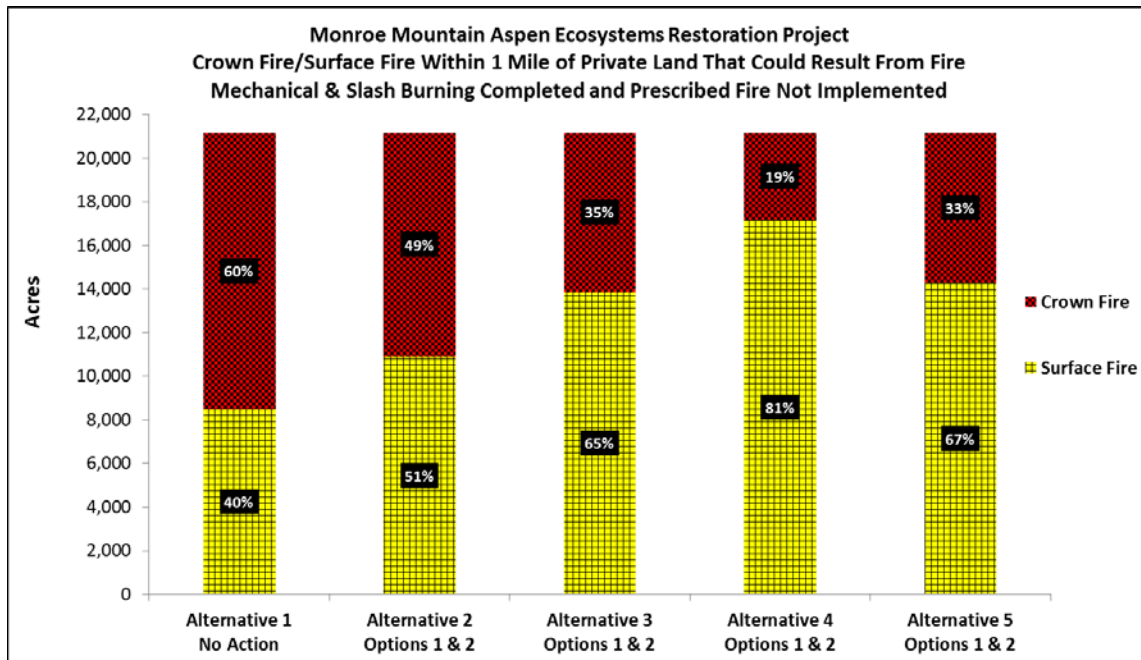


Figure 36: Monroe Mountain Aspen Ecosystems Restoration Project. Crown Fire/Surface Fire within 1 Mile of Private Land That Could Result From Prescribed Fire. Mechanical & Slash Burning Completed and Prescribed Fire Not Implemented.

Crown Fire and surface fire both reach private lands at high rates under the No Action Alternative. This is of interest as crown fire is indefensible utilizing ground firefighters. Surface fire may be defensible depending on the fire intensity and flame length. More surface fire equates to a higher defensibility in keeping fire off private lands.

No Action produces 60% crown fire and 40% surface fire. Each action alternative lowers the amount of crown fire. Alternative 2 shows 49% crown fire versus 60% crown fire under No Action. Alternatives 3 and 5 shows 35% and 33% respectively versus 60% crown fire under No Action. Alternative 4 produces the best outcome with 19% crown fire versus 60% crown fire under the No Action Alternative and this is before the prescribed fire has been completed.

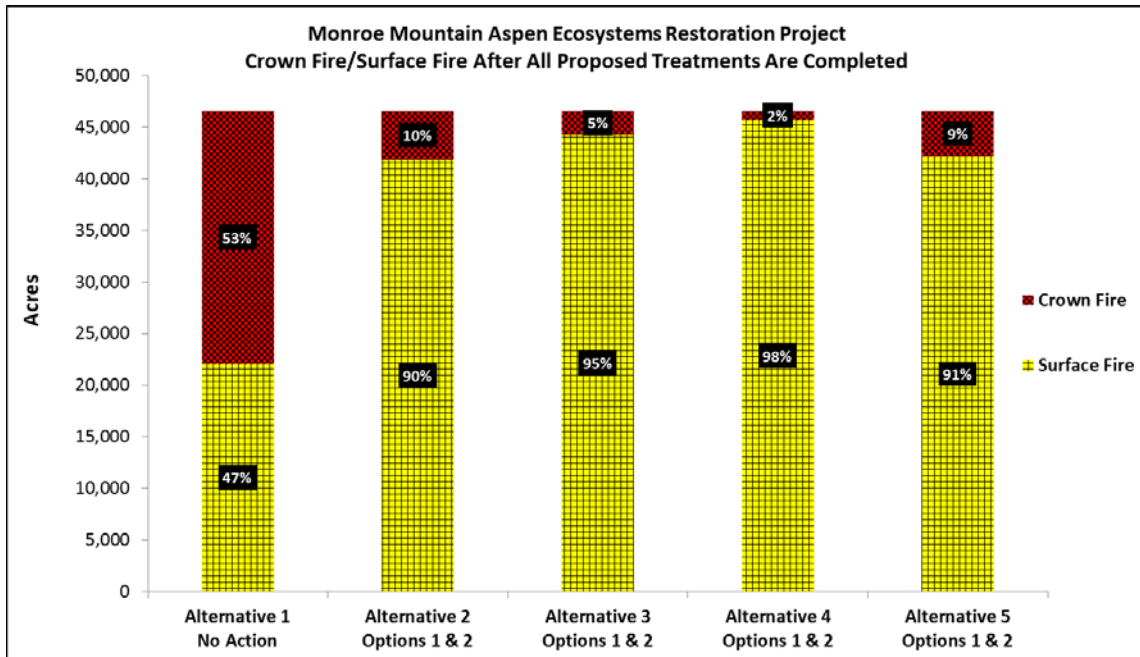


Figure 37: Monroe Mountain Aspen Ecosystems Restoration Project Crown Fire/Surface Fire After All Proposed Treatments Are Completed.

No Action Alternative exhibits 53% crown fire. All Action Alternatives result in less crown fire than the No Action Alternative. Alternative 2 shows 10% crown fire versus 53% crown fire under No Action. Alternatives 3 and 5 show 5% and 9%, respectively, versus 53% crown fire under No Action. Alternative 4 produces the best outcome with 2% crown fire versus 53% crown fire under the No Action Alternative after all proposed treatments are completed.

Fire Activity Index

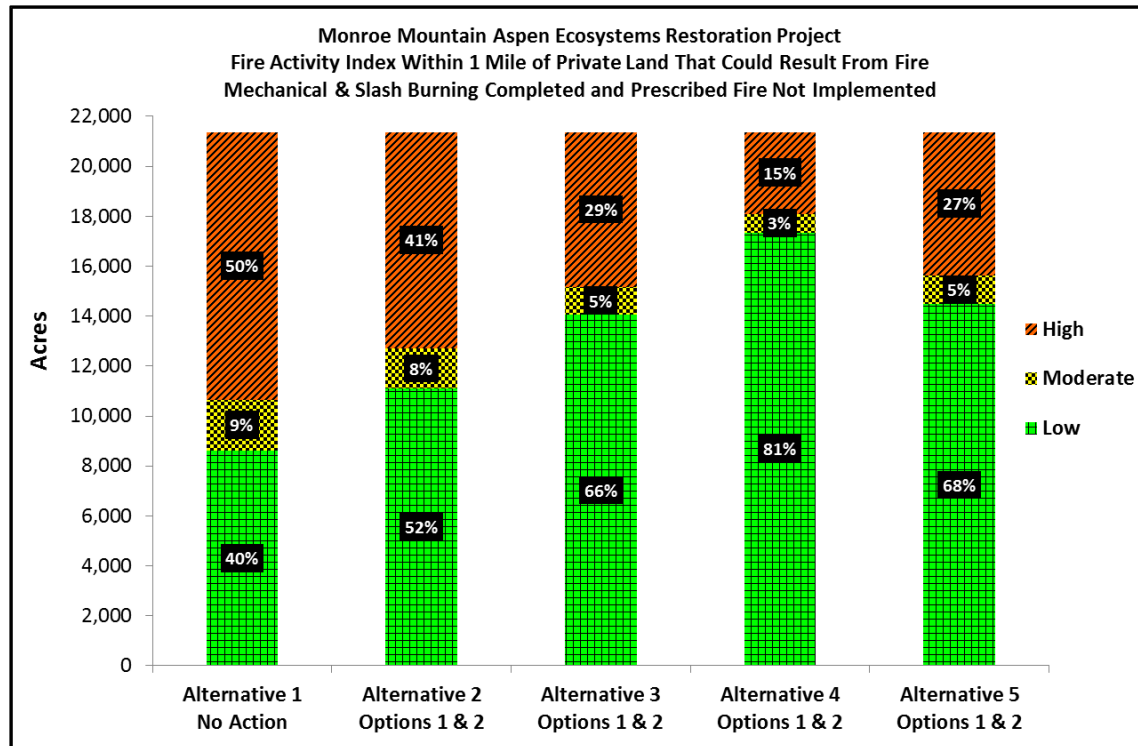


Figure 38: Monroe Mountain Aspen Ecosystems Restoration Project. Fire Activity Index within 1 Mile of Private Land That Could Result From Prescribed Fire. Mechanical & Slash Burning Completed and Prescribed Fire Not Implemented.

A Fire Activity Index was developed, combining flame length, spotting and crown fire parameters summarized from the fire modeling to show an overall difference among alternatives. These data are summarized in Figure 38 and Figure 39. Alternative 4 best lowers the overall Fire Activity Index within a mile of private land at 81% low compared to 40% low under No Action as in single indicators previously described. Alternative 4 also shows a lower amount of high fire activity at 15% compared to 50% under No Action. Alternative 2 shows the following fire activity: 52% low, 8% moderate and 41% high, compared to No Action with 40% low, 9% moderate and 50% high. Alternative 3 shows the following fire activity: 66% low, 5% moderate and 29% high, compared to No Action with 40% low, 9% moderate and 50% high. Alternative 4 shows the following fire activity: 81% low, 4% moderate and 15% high, compared to No Action with 40% low, 9% moderate and 50% high. Alternative 5 shows the following fire activity: 68% low, 5% moderate and 27% high, compared to No Action with 40% low, 9% moderate and 50% high.

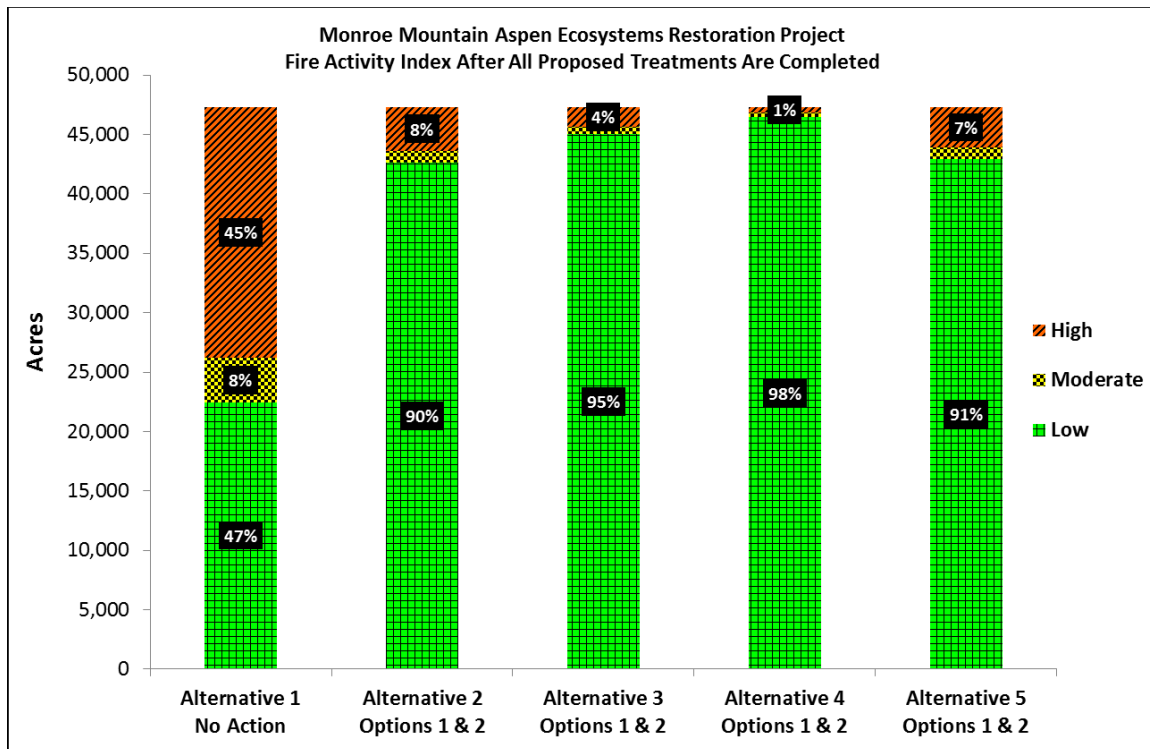


Figure 39: Summary of Alternatives 1-5. Fire activity index (compilation of flame lengths, spotting, and crown/surface fire) that could result after all proposed mechanical and slash burning (options 1 and 2) and prescribed fire are completed.

Once all treatments are completed, Alternative 4 provides the lowest overall fire activity index at 98% Low. One percent each remains in the high and moderate categories. The No Action Alternative leaves 45% of the area in high condition with 8% in Moderate. Again, all Action Alternatives lower the fire activity index. Alternative 2 causes 90% of the area to move to Low. Alternative 3 moves 95% of the area to Low, more than double that of the No Action. Alternative 5 also almost doubles the No Action Alternative at 91% Low fire activity index.

Cumulative Effects

Assumptions

For purposes of this cumulative effects analysis, the State of Utah has a history of working with landowners on improving defensible space around cabins. Some defensible space treatments on private lands have already occurred. Defensible space treatments will likely continue into the future as Utah Division of Forestry, Fire and State Lands obtains cost sharing grant monies and as stewardship agreements with landowners are completed and implemented.

It is unknown where future private lands defensible space treatments will occur or at what scale or how much fuel will be removed. For purposes of this cumulative effects analysis, it is assumed that all private lands are treated similarly to what is being

proposed for the action alternatives (i.e. conifer removal from aspen and basal area 90 in the mixed conifer and spruce/fir dominated stands).

The treatment areas for each of the action alternatives with the additional acreage from the Box Creek Fuels Reduction Project, Monument Peak Fuels Reduction Project, Cove Timber Sales, Marysvale Fire, and other past/present/reasonably foreseeable vegetation treatment projects/wildfires (Table 9, Table 10, and Table 11) in the aspen, mixed conifer, and spruce/fir dominated areas are included in this cumulative effects analysis.

Flame Lengths

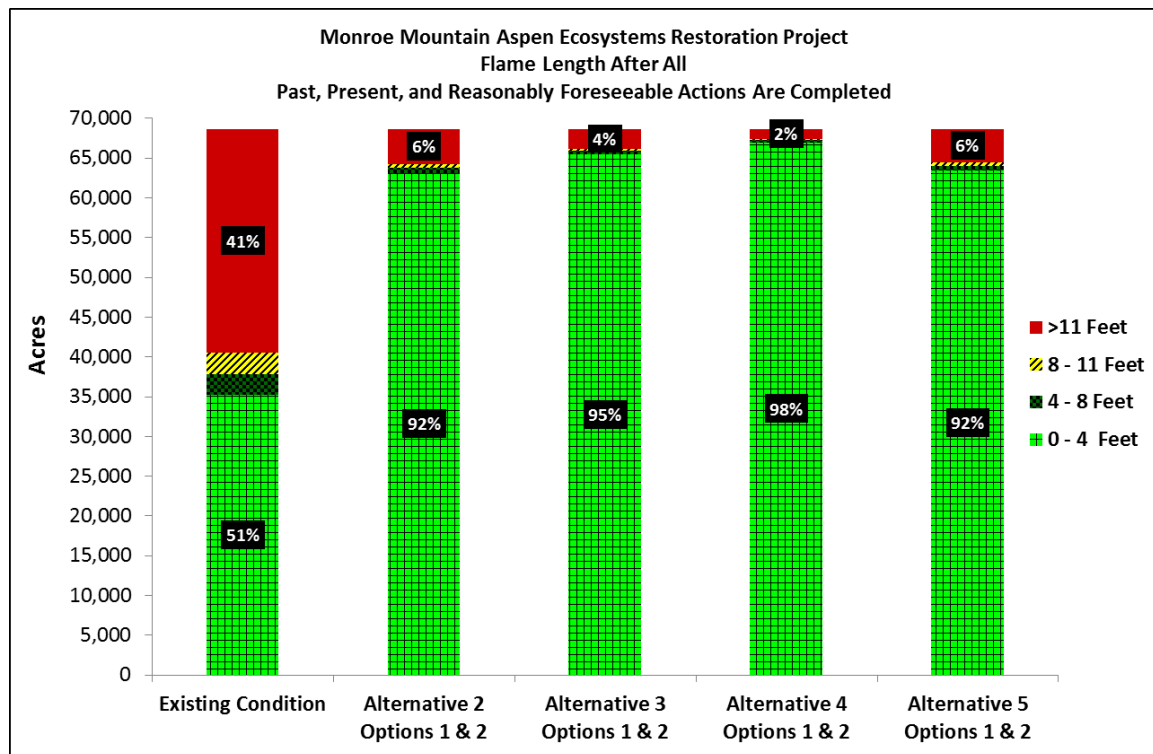


Figure 40: Monroe Mountain Aspen Ecosystems Restoration Project Flame Length After All Past, Present, and Reasonably Foreseeable Actions Are Completed.

All of the action alternatives lowered flame lengths across the treatment areas in the short term. More acres exhibiting flame lengths less than 4 feet allow for firefighters to use direct attack to limit fire spread. The existing condition shows 51% with 0-4 foot flame lengths, about 8% with flame lengths between 4 and 11 feet, leaving 41% with 11 feet or higher flame lengths. All action alternatives more than doubled the acreage and percentage of the area with flame lengths below 4 feet: Alternative 2 shows 92%, Alternative 3 shows 95%, Alternative 4 shows 98%, and Alternative 5 drops back down to 92%. Alternative 4 best lowers overall flame lengths across the cumulative effects area once all treatments are completed, thus increasing firefighters' abilities to directly attack flames near private lands.

Over the long term wildfires are likely to occur within the analysis areas. The size and severity of these fires will vary. Based on past wildfires within the analysis area, the results will be an improvement in diversity of plant species, vegetation structure and age classes for all vegetation types. Fuels will begin to increase over time as the stands re-establish.

Spotting

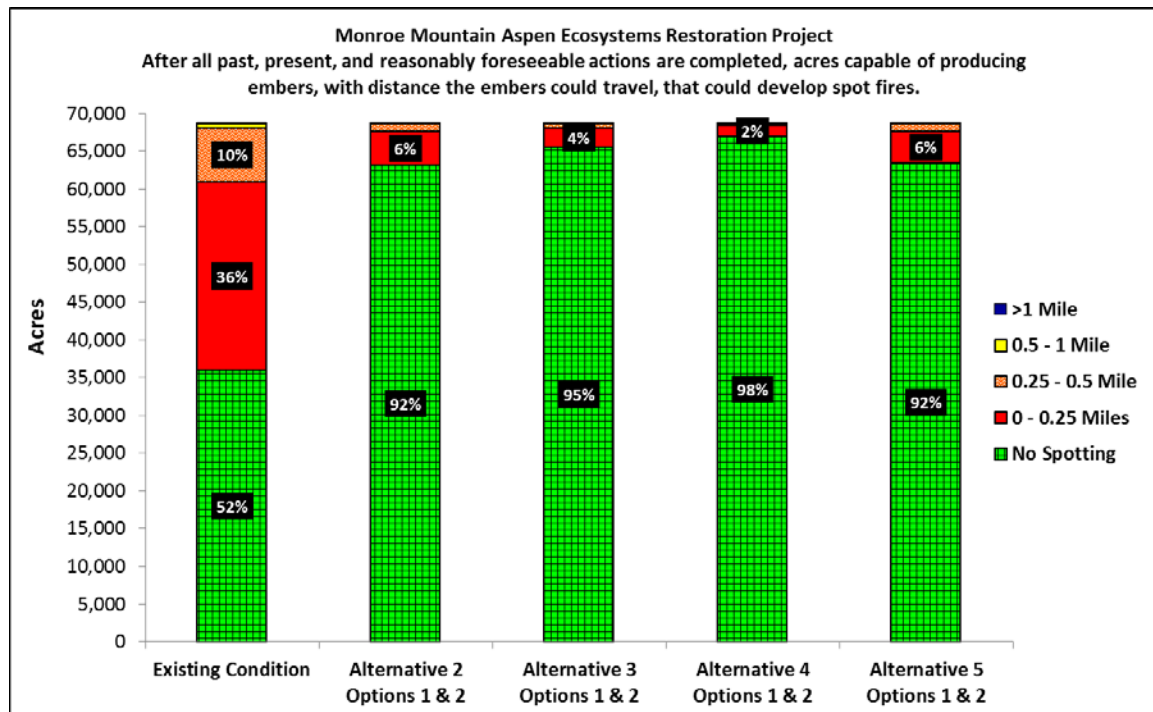


Figure 41: Monroe Mountain Aspen Ecosystems Restoration Project After all past, present, and reasonably foreseeable actions are completed, acres capable of producing embers, with distance the embers could travel that could develop spot fires.

All of the action alternatives lowered ember production across the treatment areas in the short term. Figure 41 shows that with No Action, no embers are created from 52% of the area, 36% of the area can produce embers up to ¼ mile, 10% can produce embers ¼ to ½ mile and less than 1% can produce embers which can travel up to a mile. All action alternatives greatly lessen the total ember production. Alternative 2 exhibits no spotting over 92% of the area, 6% can produce embers up to ¼ mile and 2% can produce embers which can travel up to a mile. Alternative 3 exhibits no spotting over 95% of the area, 4% can produce embers up to ¼ mile and 1% can produce embers which can travel up to a mile. Alternative 4 exhibits no spotting over 98% of the area, 2% can produce embers up to ¼ mile and less than 1% can produce embers which can travel up to a mile. Alternative 5 exhibits no spotting over 92% of the area, 6% can produce embers up to ¼ mile and 2% can produce embers which can travel up to a mile. Alternative 4 produces the best results for addressing Issue 2 with over 65,000 acres unlikely to spot once all proposed treatments are completed.

Crown Fire

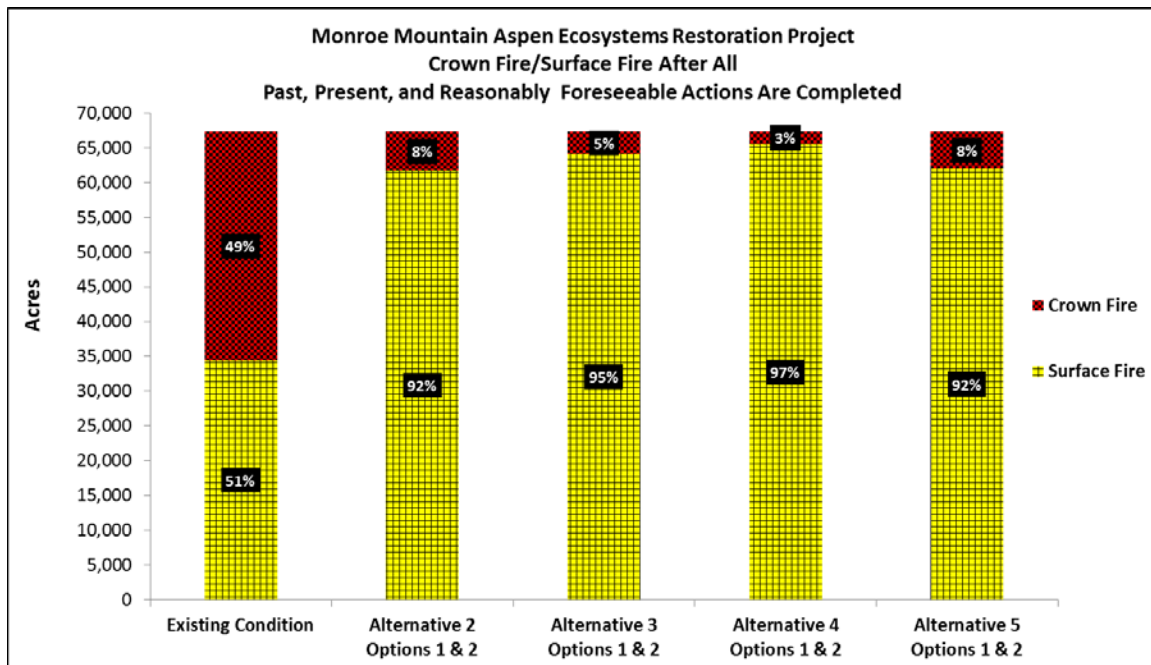


Figure 42: Monroe Mountain Aspen Ecosystems Restoration Project Crown Fire/Surface Fire After All Past, Present, and Reasonably Foreseeable Actions Are Completed.

In Figure 42, the No Action Alternative exhibits 49% crown fire post-treatment across the cumulative effects area. All Action Alternatives result in less crown fire than the No Action Alternative. Alternative 2 shows 8% crown fire versus 49% crown fire under No Action. Alternatives 3 and 5 show 5% and 8%, respectively, versus 49% crown fire under No Action. Alternative 4 produces the best outcome for the issue addressed with 3% crown fire versus 49% crown fire under the No Action Alternative after all proposed treatments are completed.

Fire Activity Index

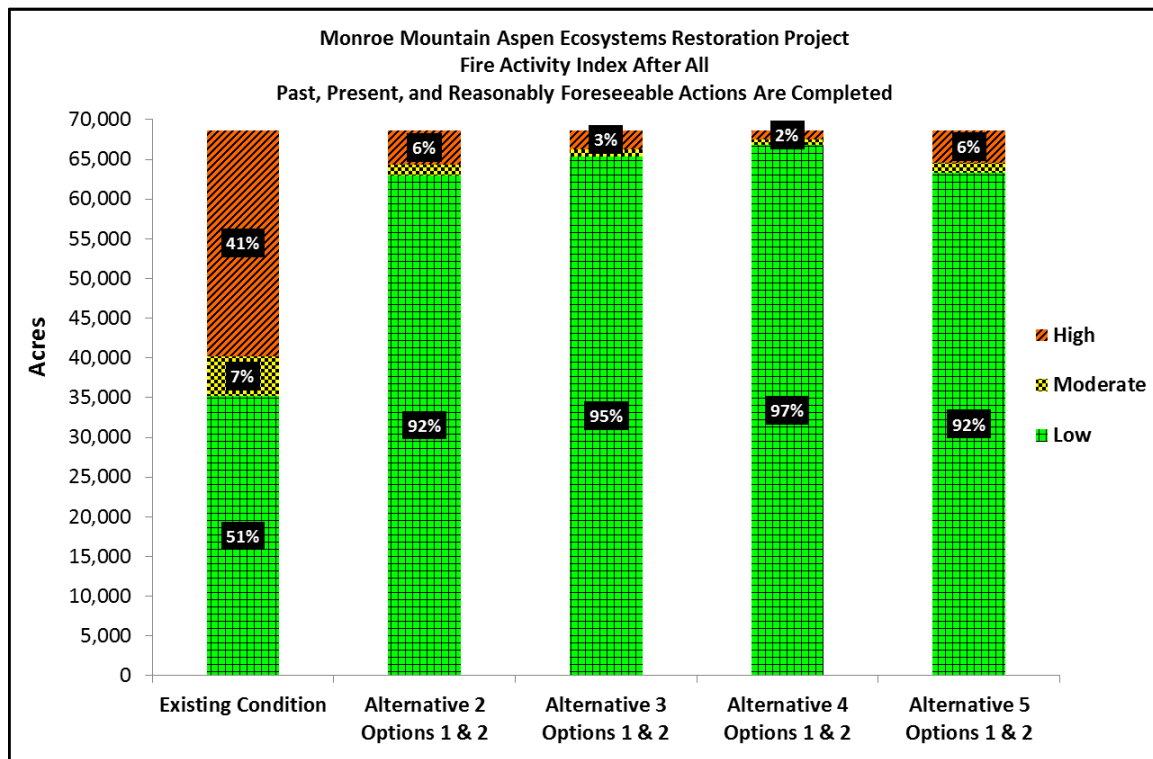


Figure 43: Fire Activity Index After All Past, Present and Reasonably Foreseeable Actions Are Completed.

Once all treatments are completed, Alternative 4 provides the lowest overall fire activity index at 97% Low. As shown in Figure 43, 3% remains in the high and moderate categories. The No Action Alternative leaves 41% of the area in High condition with 7% in Moderate. Again, all Action Alternatives lower the fire activity index. Alternative 2 causes 92% of the area to move to Low. Alternative 3 moves 95% of the area to Low, more than double that of No Action. Alternative 5 almost doubles the No Action Alternative at 92% Low fire activity index. Alternative 4 produces the best outcome with over 65,000 acres exhibiting a Low Fire Activity Index.

Irreversible and Irretrievable Commitments of Resources

Excessive utilization needs to be addressed before fire or other treatments are returned to the system (U.S. Department of Agriculture 1994). If one goal of management is to restore aspen, then animal use needs to be monitored, evaluated, and adjusted. Otherwise, animals utilizing the aspen regeneration can slow or defeat restoration efforts (Bartos in: Hood, 2007).

Conclusions

An increase in safety to firefighters and the public is expected from all action alternatives due to treated fuels exhibiting overall lower fire behavior. According to National Interagency Fire Center data, from 1990 to 2013, an average of 18 firefighters were killed annually in the line of duty. Seventeen firefighters have lost their lives while fighting fires in the state of Utah since 1961 (NIFC, 2013).

Proactive fuels management has been shown to be effective in lowering risk to people and private property across the country, and that would be an expected outcome once all the treatments were complete. The largest increase in firefighter and human safety would result from Alternative 4. The least risk to private property also results from Alternative 4 as proposed. It treats the most acres both mechanically and with fire, reducing fuels and therefore lowering fire behavior across the treatment areas.

After this analysis was completed an additional Northern goshawk nest with its associated territory was found near Indian Peak. Approximately 310 acres of the territory overlap this aspen project. If these 310 acres were not treated, there would be little impact to firefighter and public safety. The 310 acres are not close to private lands to have a negative effect if left untreated.

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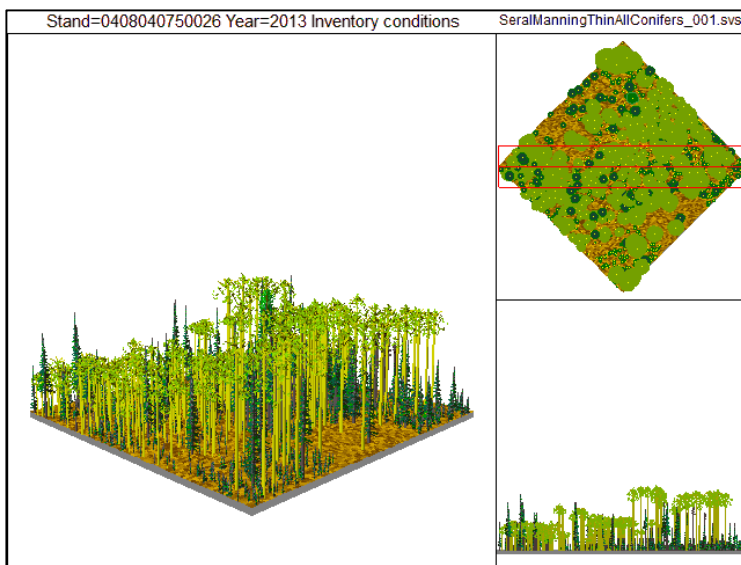
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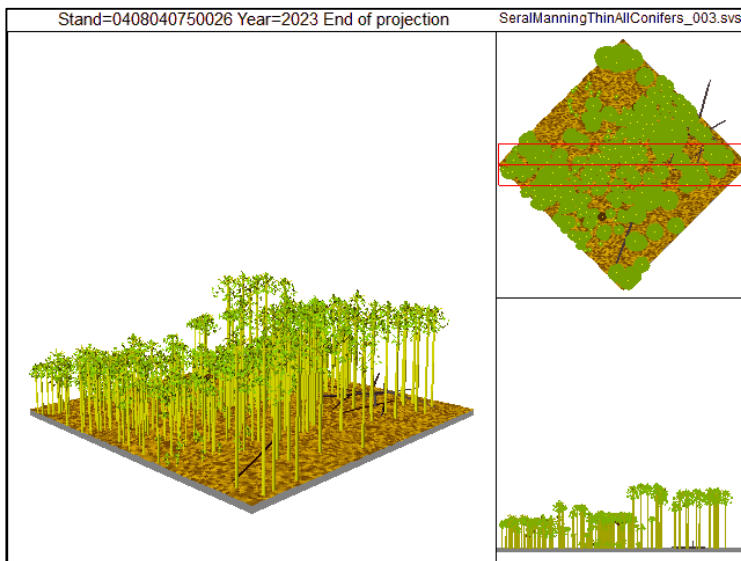
Fire Ecology, Fire and Fuels

Monroe Mountain Aspen Ecosystems Restoration Project

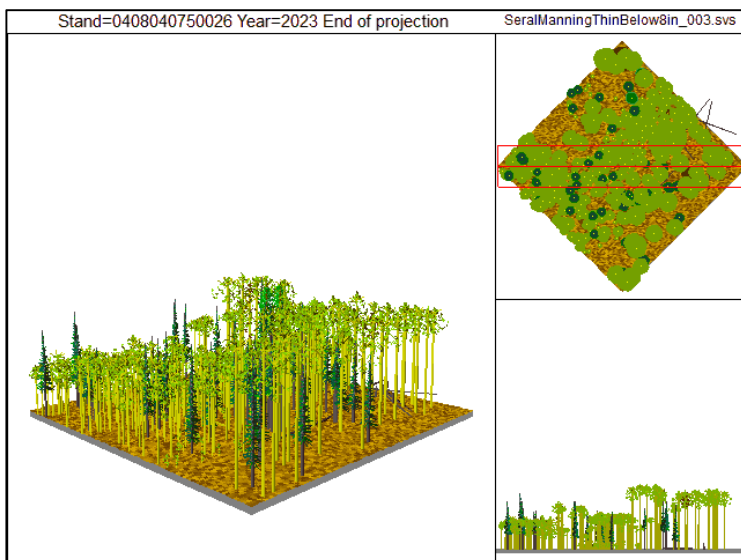
Appendix A: Forest Vegetation Simulator (FVS) Depictions



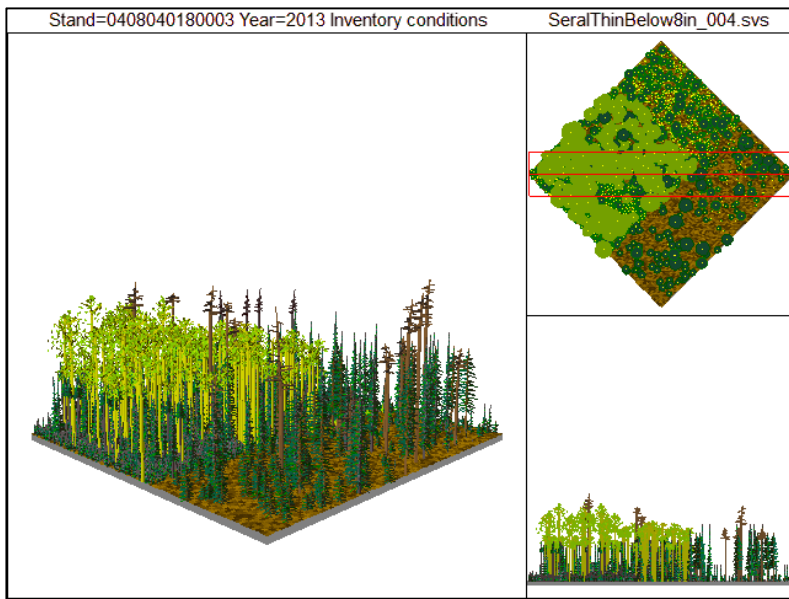
Picture 1: Seral aspen stand 750026. Depiction of current condition. This stand is located near Manning Meadows Reservoir.



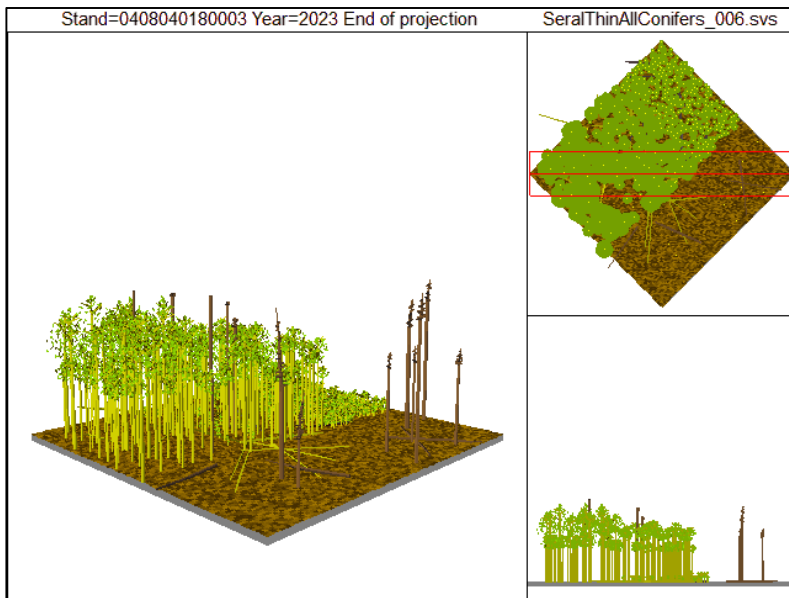
Picture 2: Seral aspen stand 750026. Depiction following removal of conifer. This stand is located near Manning Meadows Reservoir.



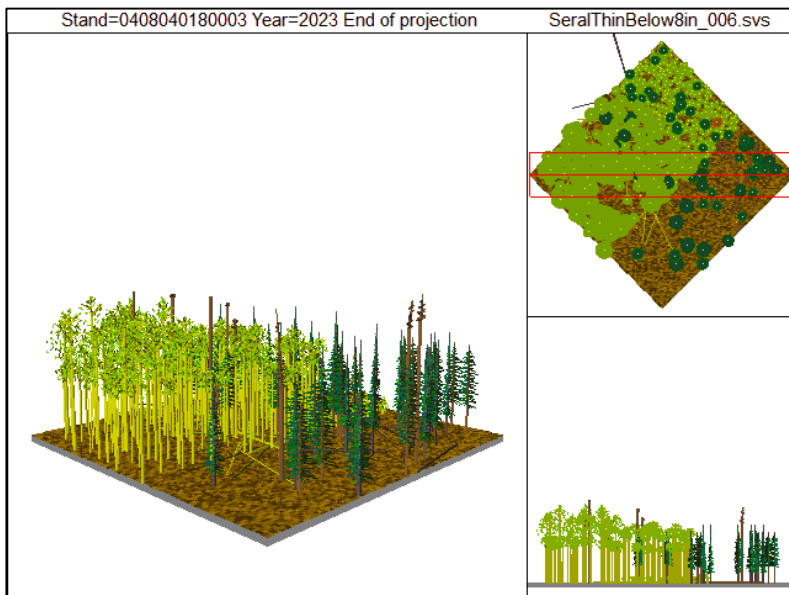
Picture 3: Seral aspen stand 750026. Depiction following removal of conifer up to 8" DBH. This stand is located near Manning Meadows Reservoir.



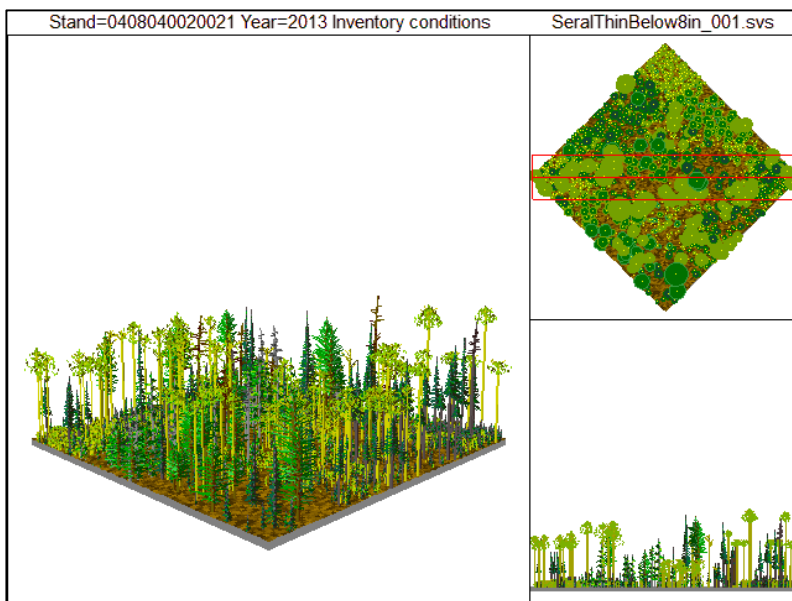
Picture 4: Seral aspen stand 180003. Depiction of current condition.



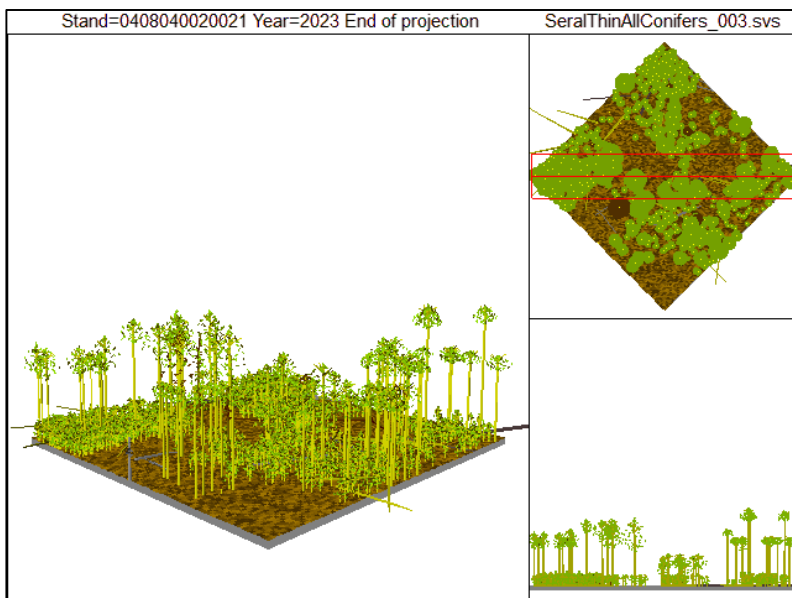
Picture 5: Seral aspen stand 180003. Depiction following removal of conifer.



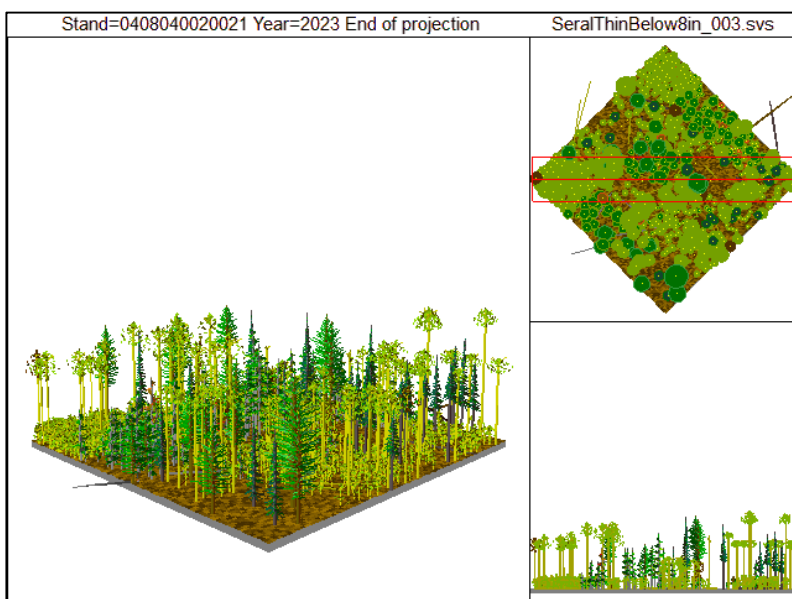
Picture 6: Seral aspen stand 180003. Depiction following removal of conifer up to 8" DBH.



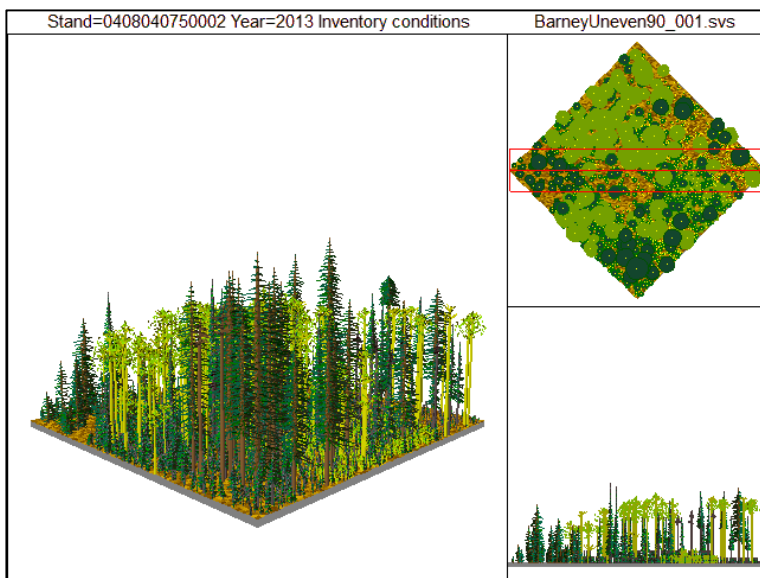
Picture 7: Seral aspen stand 20021. Depiction of current condition.



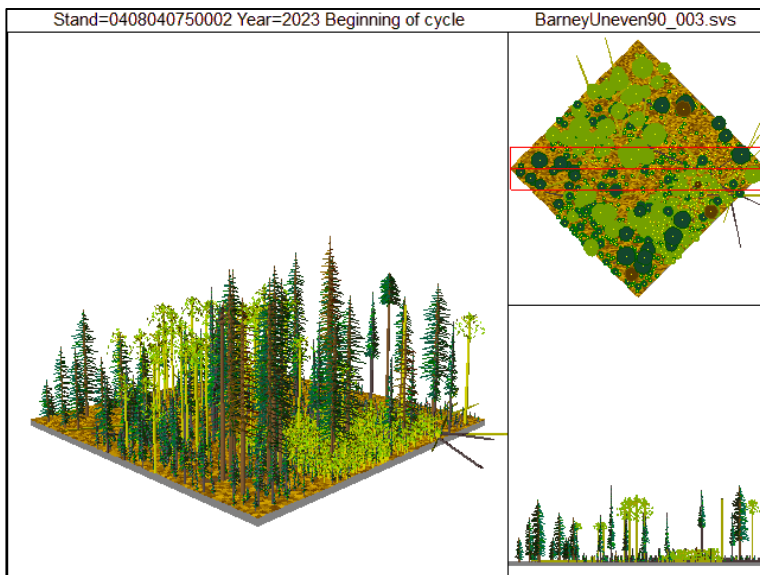
Picture 8: Seral aspen stand 20021. Depiction following removal of conifer.



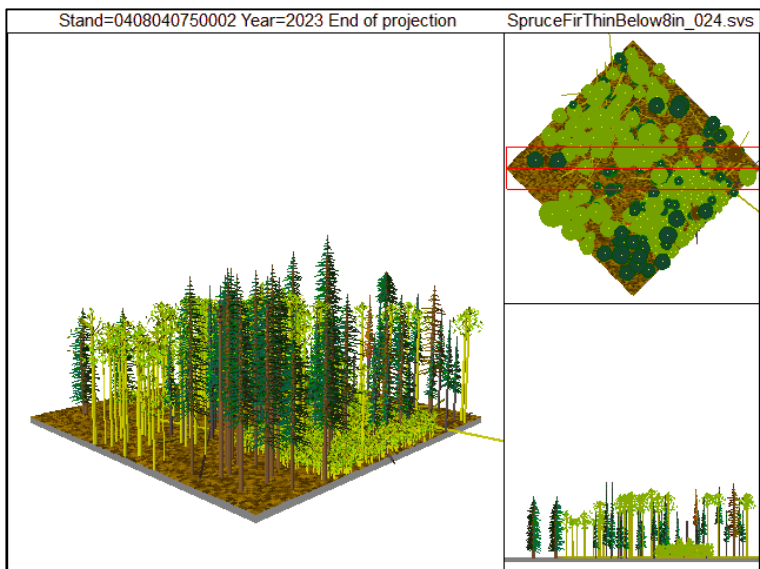
Picture 9: Seral aspen stand 20021. Depiction following removal of conifer up to 8" DBH.



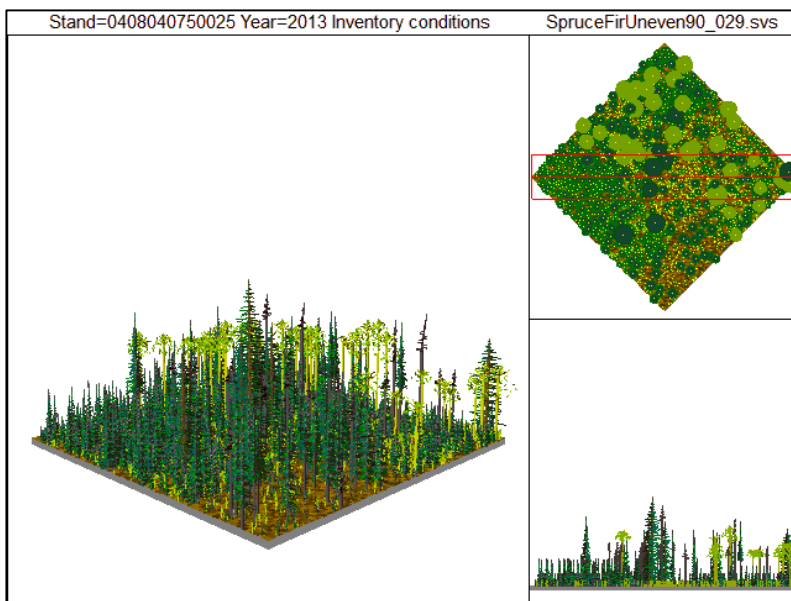
Picture 10: Spruce-fir stand 750002. Depiction of current condition. This stand is located near Barney Lake.



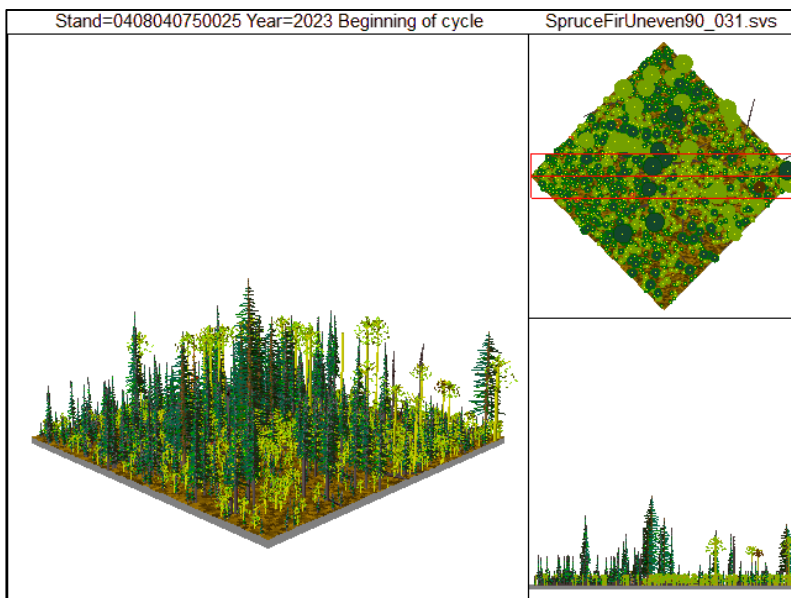
Picture 11: Spruce-fir stand 750002. Depiction following removal of conifer to BA 90. This stand is located near Barney Lake.



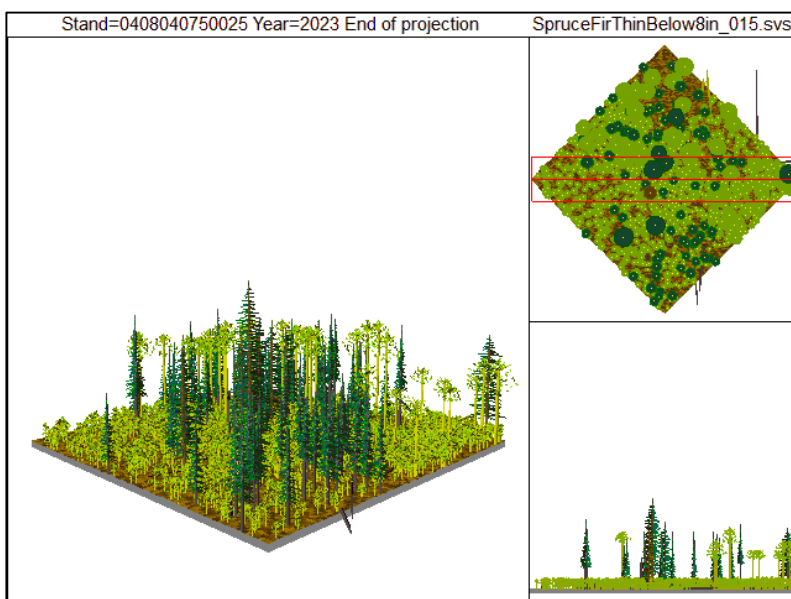
Picture 12: Spruce-fir stand 750002. Depiction following removal of conifer up to 8" DBH. This stand is located near Barney Lake.



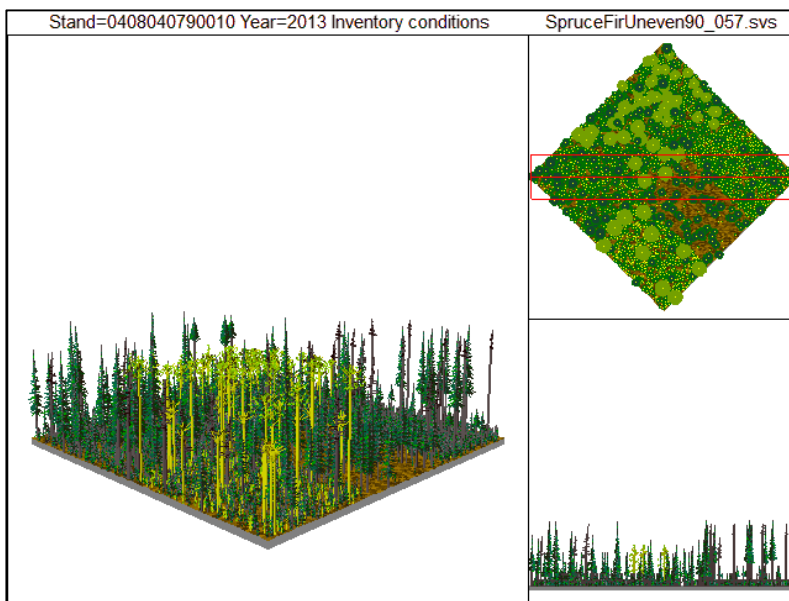
Picture 13: Spruce-fir stand 750025. Depiction of current condition.



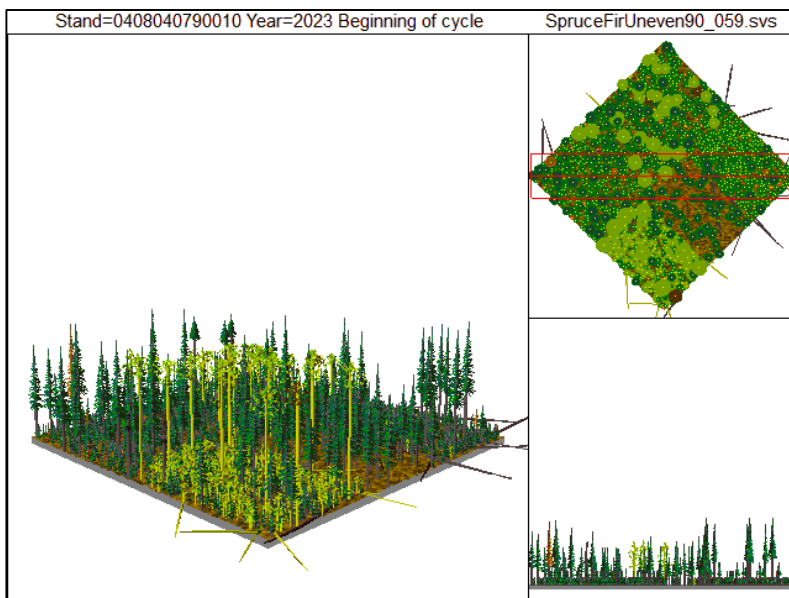
Picture 14: Spruce-fir stand 750025. Depiction following removal of conifer to BA 90.



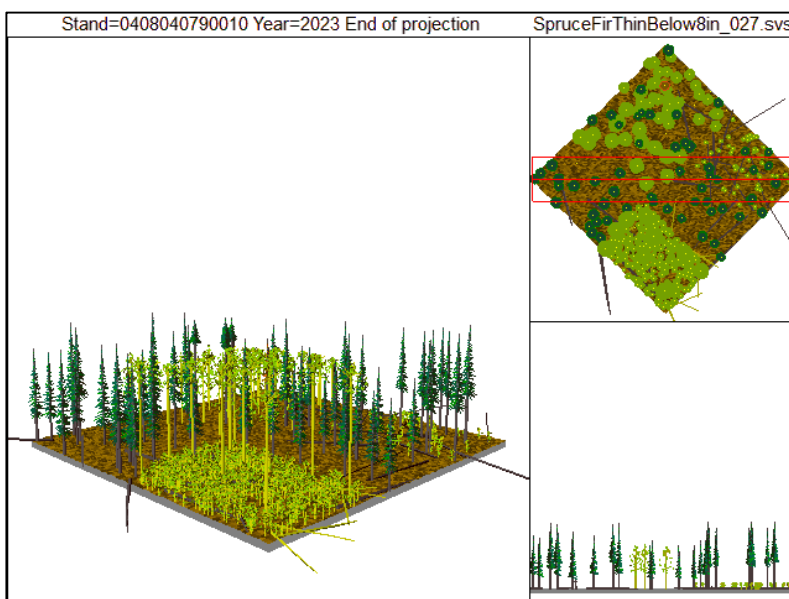
Picture 15: Spruce-fir stand 750025. Depiction following removal of conifer up to 8" DBH.



Picture 16: Spruce-fir stand 790010. Depiction of current condition.



Picture 17: Spruce-fir stand 790010. Depiction following removal of conifer to BA 90.



Picture 18: Spruce-fir stand 790010. Depiction following removal of conifer up to 8" DBH.

Fire Ecology, Fire and Fuels

Monroe Mountain Aspen Ecosystems Restoration Project

Appendix D: Browsing Thresholds and Adaptive Management Pursuant to Aspen
Restoration on Monroe Mountain; 15 January 2014

Browsing Thresholds and Adaptive Management Pursuant to Aspen Restoration on Monroe Mountain 15 January 2014

Goals:

- Establish thresholds of maximum percent browse for a given initial (post-treatment) or sustained (untreated 'stable' aspen) density of recruits that are expected to result in adequate recruitment to perpetuate the aspen stand.
- Establish timely adaptive management responses that will take place if thresholds are not met.
- Offer these recommendations fully recognizing that livestock and wildlife management decisions are made within well-established policy structures in USDA-Forest Service and Utah Division of Wildlife Resources, respectively.

Needed:

Detection methods that document shoot density, height progression, and browsing intensity, as they may vary independently

1) Aspen-mixed conifer post-treatment (prescribed fire and/or mechanical) areas

- a. Characteristic sprouting: a dense stand of similar-aged (cohort) aspen sprouts, although some stands may exhibit relatively weak sprouting initially due to depleted root systems, genetic variation, shading by conifers, or other factors.
- b. A proposed quantitative threshold: Use the chart and figure below, adapted from estimation of the maximum browsed aspen allowed that would assure the conservative outcome of at least 400-600 recruits¹/acre (i.e. 1,000-1,500 recruits/hectare ; Mueggler 1989, Campbell and Bartos 2001) (Attachment A and B).
 - i. Assumptions for the probability table and figure
 1. Once a shoot is browsed (majority of top 6" [150 mm] of leaders,) the probability of it recruiting into the overstory is extremely low.
 2. A conservative minimum of 1,000 saplings²/acre (2,500 saplings /ha) is needed to regenerate a fully stocked aspen stand.
 3. Unbrowsed shoots will reach a relatively safe height (approximately 6' or 1.8 m) in 4-6 years.
 4. Shoots occur as a single pulse or cohort (same or similar age) of regeneration (no secondary regeneration).
 5. There is no mortality to other causes.³

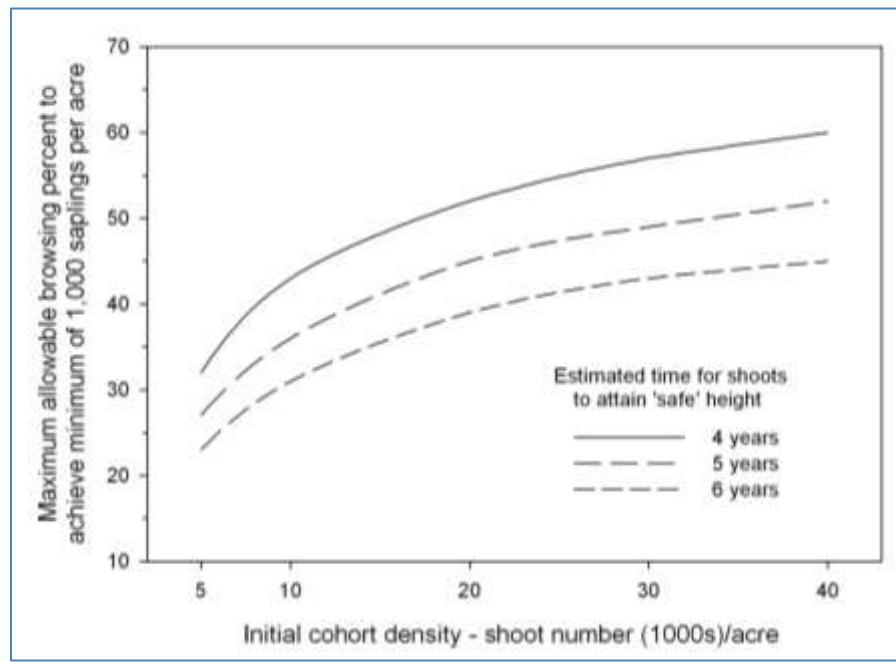
¹ A recruit is defined as an aspen shoot that has successfully reached full canopy height.

² A sapling is an aspen shoot = 6-12' (1.8-3.7 m) height

6. The level of browsing as defined by the percent of total shoots browsed is constant (from year to year and across spatial variation in shoot density).
7. Browsers show no preference between browsed and un-browsed shoots.
- ii. The assumptions will not hold in the field but the table and figure provide an initial basis for deriving appropriate thresholds that predict success or failure for aspen recruitment after treatments (mechanical or fire) that result in a range of initial densities.
- iii. Application of the table or figure will require a method to select the appropriate number of years (i.e. 4-6) for shoots to attain 'safe' heights. This can be based on site productivity, weather conditions, cumulative experience, etc.

2) Table 1. Suggested annual browse thresholds.

Years after which 1,000 aspen saplings ($\geq 6'$ tall)/acre will be present	5,000 initial sprouts/acre	10,000 initial sprouts/acre	20,000 initial sprouts/acre	30,000 initial sprouts/acre	40,000 initial sprouts/acre
	percent browse				
4	32	43	52	57	60
5	27	36	45	49	52
6	23	31	39	43	45



³ It is true that at high densities (e.g. 20,000 shoots per acre), reductions in stem density through natural thinning will be substantial. This thinning will continue in the sapling stage but this is accounted for as the stand can thin from 1,000 to 400-600 stems per acre as the stand matures.

Figure 1. Projected maximum browse pressure in relation to initial aspen shoot density and time (years) needed for shoots to reach a safe height.

- c. Suggested browse threshold detection
 - i. Use two perpendicular belt transects (e.g., 6' x 100' or 2m x 30m) per plot, and include pellet counts for insight into use by types of ungulates.
 - ii. A minimum of one plot per 300 acres (120 ha) treated, but a greater number of plots when needed to assess percent browse.
 - iii. The plots should reflect the variability of the treatment area. Care should be taken to adequately represent areas of known higher use and/or vulnerability, e.g., <30% slope, <30 pre-treatment aspen stems/acre among the conifer.
 - iv. Browse thresholds for a specific treatment are violated (exceeded) when:
 - 1. Across all plots, average plot browse percentage exceeds the maximum allowable browse threshold calculated from plot shoot density ; or
 - 2. At least 40% of the individual plots associated with the treatment exceed the percent browse threshold.⁴
 - v. The above monitoring scheme will be adapted as necessary on the basis of experience using this scheme.
- d. Browse threshold benchmarks for post-treatment aspen-mixed conifer
 - i. Browse = apical meristem damaged or removed on a majority of leaders within 6 vertical inches of the tallest leader.
 - ii. More than 20% of sprouts are browsed each year in stands with less than 5,000 initial post-treatment sprouts/acre.
 - iii. More than 27% of sprouts are browsed each year in plots with 5,000-10,000 initial post-treatment sprouts/acre
 - iv. More than 36% of sprouts are browsed each year in plots with 10,000-20,000 initial post-treatment sprouts per acre.
 - v. More than 45% of sprouts are browsed each year in plots with more than 20,000 initial post-treatment sprouts per acre.
 - vi. The above percent browse thresholds are comparable to those recommended by Olmstead (1979; 30%), Jones et al. (2005; 20%) and White and Feller (2001) while allowing for a greater range in sprout number. These values should be adapted as necessary on the basis of observed success in stand recruitment.
- e. Adaptive management
 - i. Scale and timing of aspen restoration treatments: Recognizing that the scale and timing of treatments are likely to affect the level of impact that both wild and domestic grazers have on aspen response to treatments, consider designing treatments that would occur at the largest practical scale (neighborhood of 5,000 acres annually), while still being sensitive to other resource concerns (i.e. aquatics) for any given year. Adaptive management responses and their

⁴ Both elements of threshold exceedance are important to avoid outliers having determinative influence.

probability of success are expected to be highly correlated with the location, timing, and scale of treatments.

- ii. Prior to treatments, recommend to the UDWR, RAC and the Utah Wildlife Board a pre-approved antlerless hunt that could be implemented, if deemed necessary, immediately following treatments in order to reduce browse pressure adequately to facilitate greater aspen recruitment. This recommendation would be subject to the Wildlife Board and RAC approval process. If approved and following treatments, the UDWR, in coordination with the USDA Forest Service, would initiate implementation of the antlerless hunt.
- iii. Post-treatment period with no livestock use: If browse thresholds are exceeded during the period of rest from livestock use (typically 2 years post-treatment), the USDA Forest Service undertakes one or more of the following adaptive management responses in order to achieve balanced livestock and wildlife use, while avoiding exceeding browse thresholds:
 - a. Recommend to the UDWR, RAC and the Utah Wildlife Board a reduction of wild ungulate browsing pressure using antlerless hunts as needed at levels expected to result in sufficient reduction in browse to avoid surpassing browse thresholds. This recommendation would be subject to the Wildlife Board and RAC approval process.
 - b. Co-ordinate with the UDWR to hire/contract adequate number of seasonal employees and/or coordinate the use of volunteers (i.e. Dedicated Hunter Program) to spend time in treatment areas hazing wildlife at levels expected to result in sufficient reduction in browse to avoid surpassing browse thresholds.
 - c. Treatment areas be fenced for protection.
 - d. Restrict livestock use until aspen recovery objectives are met.
- iv. Post-treatment period after return of livestock to treatment area(s): If percent browse threshold is exceeded in a treatment area(s) grazed by both wild ungulates and livestock (typically after 2 years post-treatment), the USDA Forest Service undertakes one or more of the following adaptive management responses in order to achieve balanced livestock and wildlife use, while avoiding exceeding browse thresholds:
 - a. Recommend to the UDWR, RAC and the Utah Wildlife Board a reduction of wild ungulate browsing pressure using antlerless hunts as needed at levels expected to result in sufficient reduction in browse to avoid surpassing browse thresholds for combined livestock and wildlife use. This recommendation would be subject to the Wildlife Board and RAC approval process.
 - b. Co-ordinate with the UDWR to hire/contract adequate number of seasonal employees and/or coordinate the use of volunteers

- (i.e. Dedicated Hunter Program) to spend time in treatment areas hazing wildlife at levels expected to result in sufficient reduction in browse to avoid surpassing browse thresholds.
- c. Fence treatment areas.
- d. Improve time, timing and intensity of livestock grazing.
- e. Recommend to the UDWR utilize the Grass Bank Program on state Wildlife Management Areas to help offset temporary loss of livestock opportunities.
- v. The above mentioned adaptive management responses are not intended to be all inclusive. Additional or alternative adaptive management responses that are proposed, and which have been shown to be effective, should also be considered.
- vi. After overstory aspen trees are removed or killed (i.e., mechanical or burn treatment), healthy roots systems typically are able to sustain vigorous shoot growth for a limited time (2-3 years,) providing a brief opportunity to modify management when browse pressure exceeds threshold levels. Therefore, the above mentioned potential adaptive management responses have been identified for consideration as timely management responses as each treatment phase is implemented.
- vii. Although management changes that reduce wild or domestic ungulate numbers may be necessary to restore healthy aspen communities on Monroe Mountain, such changes will be viewed as temporary and will not be interpreted as support for permanent or long-term reductions in stocking levels or population objectives. The Forest Service should be actively engaged in the UDWR's elk management plan revision process in order to promote understanding and consideration of resource conditions on objectives.
- viii. If adaptive management responses are needed, the number and type of responses are anticipated to vary depending on location and timing of treatments. Considering the location, size, and timing of treatments, adaptive management responses and the probability of success are expected to vary. Decision authorities for the adaptive management responses also vary. For these reasons, continued and close communication between USDA Forest Service, UDWR, RAC, Utah Wildlife Board and all other interested stake holders is critical. The adaptive management responses are intended to avoid surpassing browse thresholds and to achieve a 1,000 saplings/acre.

3) Stable aspen stand response to changed management of ungulates and of fire and mechanical treatments in aspen-mixed conifer

- a. Long-term monitoring plots: Sixty long-term monitoring plots will be established to represent the range of conditions thought to occur in stable aspen stands on Monroe Mountain. Aspen stands will be classified as stable when all of the following criteria are met.

- i. Mature conifer stem counts per unit of area (acre) < 20% of total mature tree stem count (surrogate for BA [basal area] or cover)
- ii. Total conifer stems (all sizes) < 40/acre (100/ha)
- iii. Judgment will be used when required. For example, apparent intermixing of stable and seral conditions across uniform topography may require moving the plot to where stable conditions prevail. In addition, the age/size structure of conifer populations might be used supplementally to infer stand stability.

Data will be collected on overstory condition, aspen regeneration and recruitment (including browse use), fecal pellets and cow pies and understory for these plots starting in 2013. These data will provide a baseline dataset from which to detect change in subsequent years. Data for aspen shoot density, height, and percent browse will continue to be collected on an annual basis. Overstory and understory data will be collected at longer intervals (3-5 years).

- b. Stable aspen stand type classification: Although it is well recognized that in many areas stable aspen is not recruiting, it should be assumed that some plots will be located in stands that are appropriately described as self-replacing. Self-replacing stands may be classified into three basic conceptual types with intermediate conditions expected. These stand types are: 1) stands of dense, even-aged stems that have successfully recruited following recent (10-30+ yrs.) disturbance (e.g. fire or mechanical) to heights that they are now safe from ungulate browse pressure and generally exhibit little or no new regeneration; 2) stands with depleted overstories but with vigorous regeneration and ample stems in the sapling to sub-canopy size classes; or 3) multi-aged stands with stratified canopies (long time since last disturbance). It is essential that we be able to characterize all types of self-replacing, stable aspen stands using reasonable metrics to in turn be able to quantify the variables that will be used in their classification.

- i. **Stable Aspen stand type 1 (SA1)** will have a minimum of 1,000 live stems/ acre (2,470 stems/ha). This is approximately double the density of a fully stocked aspen stand (Mueggler 1989, Guidelines for Aspen Restoration 2010). Subsequently, additional natural thinning is expected. Aspen stands with densities greater than 1,000 live stems/acre are common when vigorous suckering follows disturbance (e.g., fire) in healthy aspen stands and browse impacts remain low. Consequently, tree density is high enough that the absence of active shoot generation in SA1 stands should not be considered a disqualifier for self-replacing status.
- ii. **Stable Aspen stand type 2 (SA2)** is what might be expected when stands with depleted overstories exhibit sufficient recruitment that full recovery is expected as stems mature. In general, recruitment synchrony for self-replacing SA2 stands is intermediate between that of the disturbance-initiated SA1 stands and that of the more continuous stable aspen type 3 (SA3) stands described below. The upper density limit for live canopy trees is arbitrarily set at 200/acre for the SA2 stand type, or less than half that of a fully stocked aspen stand. SA2 stands

are further sub-divided into four levels based upon the combined density of sapling and sub-canopy trees⁵ relative to the density of live canopy trees. The levels are defined as follows: **full self-replacing (SA2-F)** when the combined density of saplings and sub-canopy trees is $\geq 200\%$ of the density of live canopy trees; **transitional self-replacing (SA2-T)** when the combined density of sapling and sub-canopy trees is $\geq 100\%$ but $< 200\%$ of the live canopy-tree density; **marginal self-replacing (SA2-M)** when the combined density of sapling and sub-canopy trees is $\geq 50\%$ but $< 100\%$ of the live canopy-tree density; and **non-self-replacing (SA2-N)** when the combined density of sapling and sub-canopy trees is $< 50\%$ of the live canopy-tree density.

Table 2. Threshold benchmarks for Full, Transitional, and Marginal self-replacing levels of Class 2 stable aspen (SA2).

Density of live canopy trees	Minimum sapling + sub-canopy tree density for SA2-F level	Minimum sapling + sub-canopy tree density for SA2-T level	Minimum sapling + sub-canopy tree density for SA2-M level
(trees/acre)			
200	400	200	100
150	300	150	75
100	200	100	50
50	100	50	25
25	50	25	13

- iii. All self-replacing, stable aspen stands not classified as type SA1 or SA2 will by default be classified as **stand type 3 (SA3)**; multi-aged stands with densities that are greater than 200 and less than 1000 live trees/acre. Stratified canopies of continuous or pulsed recruitment and a basal level of new shoot production are descriptive of SA3 stands. In reality SA2 and SA3 stand types represent different segments on a single continuum of overstory condition; however, the corresponding recruitment effort may differ substantially between the two types as a function of overstory live-tree density and corresponding differences in apical dominance. Specifically, as canopy tree density increases for SA2, a corresponding 2-fold increase in recruitment-size stems is required to qualify for the fully self-replacing status. However for SA3 stands, sapling/sub-canopy tree density is expected to decrease with increasing canopy density (Figure 2). Thus at the low end of the SA3 spectrum (200 live canopy trees/acre), a minimum of 400 saplings/sub-canopy trees per acre are required for full self-replacing (SA3-F) status while at the high end (999 live canopy trees/acre) none are required

⁵ Sub-canopy trees are $>12'$ (3.65 m) in height with crowns clearly below the dominant canopy structure which will vary in height for mature stands with microsite conditions and genotype.

for the same. More specifically, SA3 stands will be assigned to the **SA3-F (full self-replacing)** level based upon the following equation where (a) = density of live canopy trees and (b) = combined density of saplings and sub-canopy trees.

$$b \geq a (-0.5) + 500$$

Stands will be assigned to the **SA3-T (transitional self-replacing)** level if the sapling + sub-canopy density is at least $\frac{1}{2}$ of the minimum threshold for F-SR status as indicated by the equation:

$$a (-0.5) + 500 > b \geq a (-0.25) + 250$$

Stands will be assigned to the **M-SR (marginal self-replacing)** level if sapling + sub-canopy density is at least $\frac{1}{4}$ of the minimum threshold for F-SR status as indicated by the equation:

$$a (-0.25) + 250 > b \geq a (-0.125) + 125$$

SA3 stands are assigned to the **N-SR (non-self-replacing)** level when recruiting stem densities are below the M-SR minimum threshold:

$$b \geq a (-0.125) + 125$$

Table 3. Threshold benchmarks for Full, Transitional, and Marginal self-replacing levels of Class 3 stable aspen (SA3).

Density of live canopy trees	Minimum sapling + sub-canopy tree density for SA3-F level	Minimum sapling + sub-canopy tree density for SA3-T level	Minimum sapling + sub-canopy tree density for SA3-M level
(trees/acre)			
200	400	200	100
400	300	150	75
600	200	100	50
800	100	50	25
1000	0	0	0

- c. Stable aspen improvement thresholds: Using 2013 (and possibly 2014) monitoring data, each of the 60 stable aspen plots will be classified into the appropriate class and level based upon live canopy tree and recruitment (saplings + sub-canopy trees) densities as described above. Although monitoring will continue on all plots, those plots initially classified as SA1 or SA2/SA3 level F (fully self-replacing), will not be used to determine treatment-related improvement in stable aspen because it is assumed that these plots are already fully self-replacing.

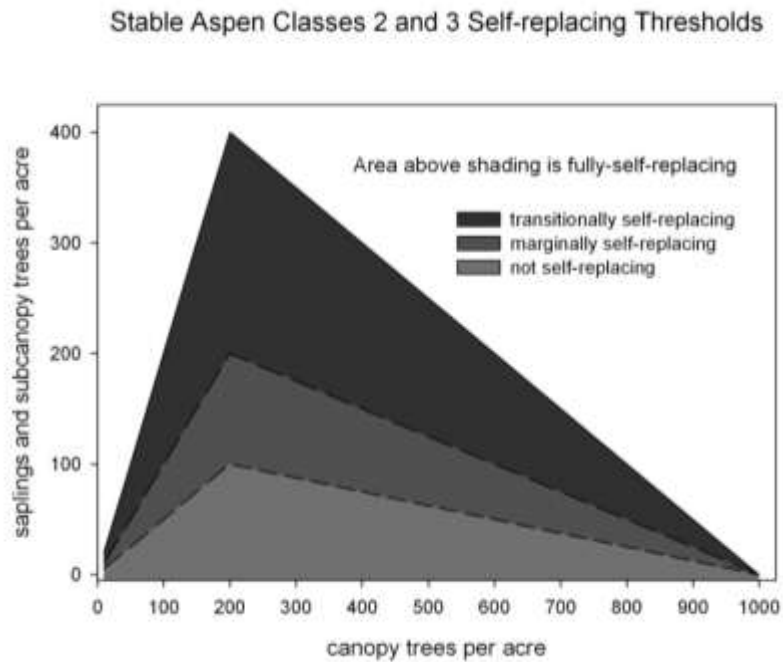
Improvement for the subset of plots initially classified in levels T (transitional), M (marginal), and N (non-self-replacing) will be recognized and documented when plots move upward from one level to another (N to M, M to T, T to F). Similarly, degradation will be acknowledged if plots drop a level.

- i. A minimum benchmark of success in restoring stable aspen on Monroe Mountain will be that average improvement for all eligible plots (SA2 and SA3 levels T, M, and N) must be equal to one full level increase as a benefit of the project. Thus, for every plot that fails to move up a level, another will have to move up two levels. Plot degradation (drop in levels) will also be factored in.
- ii. It is not acceptable to have to wait 10-15 years until the entire Monroe Mountain project is completed to determine the degree to which it has been successful. A process must be adopted to incrementally assess whether management actions are leading to the desired outcome and, if not, additional management actions on the mountain will be warranted.
- iii. Aspen response (including stable aspen) should be proportional to the area treated (as a percent of the total area planned for treatment) across the duration of the project. It may not be possible to accurately predict how browse relief will be distributed spatially. Therefore, stable aspen improvement should be interpreted at the broadest spatial scale (all 60 plots). For example, one scenario might allow that 10% of the area planned for treatment, be treated. Assuming in the same scenario that 50 of the 60 stable aspen plots are classified as being eligible for improvement (as defined above) then an expectation for reclassification to at least one level higher might be expected for a minimum of 5 (10%) of the 50 eligible plots, with no plots being downgraded in response to this first year of treatment. It is anticipated that level changes may be detectable within 3 years of treatment.
- d. Adaptive management: A failure to detect sufficient improvement after an appropriate lag time (allowing some flexibility for unknowns such as extreme weather events) will trigger a recommendation for an appropriate adaptive management response(s) (selecting from the adaptive management responses listed above) to temporarily reduce browse pressure by domestic and/or wild ungulates sufficient to allow for stable aspen recovery. These recommendations will not be interpreted as endorsement of permanent changes in livestock or wildlife management. As additional area is treated, a proportionate increase will be expected in the number of plots that improve sufficiently to warrant reclassification to a higher level. A lag period of approximately 3 years will continue to be employed for each treatment. Hypothetically, this could result in a recommendation to reduce browse pressure after treatment of seral aspen stands even when aspen recovery within the treatment area is satisfactory but where there is no corresponding improvement in stable aspen monitoring plots. The opposite is also possible, that is we could have improvement in stable aspen but unsatisfactory results in

the treated area. Either way, under these conditions management actions designed to reduce browse pressure would be desirable.

- e. Boundaries described herein between stable aspen classes and levels of recruitment, though somewhat artificial, are based upon expert opinion and best science available. These boundaries are subject to modification if site-specific data from stable aspen plots and/or exclosures provide clear rationale for doing so. The lag period (3 years) between treatment and time of expected recruitment enhancement may also be adjusted with experience. In such cases, proposed changes and supporting rationale will be documented and subject to review prior to implementation. For this reason, continued and close communication between USDA Forest Service, UDWR, RAC, Utah Wildlife Board and all other interested stake holders is critical.
- f. Stable aspen classes and recruitment levels are based directly upon the densities of stems that reach relatively safe heights and will not initially take into account the browse intensity values that will clearly influence those densities. Patterns in annual browse data will be analyzed over time with the objective of determining how they might be incorporated to improve assessments of stable aspen condition and trajectory on Monroe Mountain.

Figure 2.



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Fire Ecology, Fire and Fuels

Monroe Mountain Aspen Ecosystems Restoration Project

Appendix FM: Fuel Modeling

Appendix FM

Fire Behavior Modeling

Mathematical modeling is defined as a method of simulating real-life situations with mathematical equations to forecast their future behavior.

<http://www.businessdictionary.com/definition/mathematical-model.html#ixzz208g6CMON>

Fire behavior modeling has been described as the intersection between science and art. Entering inputs into a computer program and collecting the outputs is the scientific part of modeling, coming up with those inputs can be very much an art.

In order to get accurate predictions, the models must be calibrated to local conditions. A common way of calibrating a model is matching its outputs to past, observed fire behavior. Once the model is sufficiently fine-tuned or calibrated to local conditions, the business of fire prediction can begin (Ager, et al, 2011).

There are many different types of fire modeling software, but all are largely based on Richard C. Rothermel's Fire-Spread Equation. An excerpt from the BehavePlus model tutorial (Heinsch, et al, 2010) describes the assumptions of the Rothermel Fire Spread Equation. There are ways to deal with many of the limitations, but it is important to be aware of them and avoid using the model predictions in situations for which they do not apply.

Head Fire: The model was developed for head fire, which is fire spreading upslope with the wind. Other modeling techniques are used to find head fire spread rate for cross-slope winds and for non-head fire spread.

Flaming Front: The model describes fire behavior in the flaming front, which is primarily influenced by fine fuels. Burning of larger fuels persists after the initial front has passed, although this aspect of the fire is not included in Rothermel's surface fire spread model.

Steady State Fire: The fire model is primarily intended to describe fires advancing steadily, independent of the source of ignition. The time that it takes for a point source fire to reach steady-state conditions is not calculated. Special care should be taken in applying predictions to prescribed fire where the behavior is affected by the pattern of ignition.

Uniform Conditions: Fuel, fuel moisture, wind, and slope are assumed to be constant during the time for which predictions are to be applied. Because fires almost always burn under non-uniform conditions, the length of projection period and choice of fuel model must be carefully considered to obtain useful predictions. The more uniform the conditions, the longer the projection time can be.

For this project the FARSITE model was used to calibrate the Landfire landscape and other modeling inputs by replicating as closely as possible the Box Creek Wildfire that occurred on Monroe Mountain in 2012. *FARSITE* is a fire growth simulation modeling system. It uses spatial information on topography and fuels along with weather and wind files. It incorporates existing models for surface fire, crown fire, spotting, post-frontal combustion, and fire acceleration into a 2-dimensional fire growth model.

FARSITE is widely used to simulate the spread of wildfires and fire use for resource benefit across the landscape. *FARSITE* computes wildfire growth and behavior for long time periods under heterogeneous conditions of terrain, fuels, and weather. *FARSITE* is a deterministic modeling system, meaning that simulation results can be directly compared to inputs. This system can be used to simulate air and ground suppression actions as well as for fire "gaming," asking multiple "what-if" questions and comparing the results. A good calibration simulation of the Box Creek Wildfire was obtained, and those inputs were then used for the rest of the modeling project.

Fuel Models

The fire behavior models use "fuel models" to represent the vegetation through which a fire burns. The fuel is described according to size classes (diameter and surface-area-to-volume ratio) of live and dead vegetation. The fuel model uses 3 dead and 2 live fuel classes along with some other variables to describe different types of vegetation including categories of grass, brush, timber, and slash. Scott and Burgan's dynamic fuel models were used in this project to represent the vegetation types on Monroe Mountain (Scott and Burgan, 2005).

The fuel models are incorporated into a Landscape (LCP) file that stores data describing terrain, tree canopy, and surface fuel (Figure 1). The source of the landscape file is LANDFIRE®. LANDFIRE is a program that provides over 20 national geo-spatial layers (e.g. vegetation, fuel, disturbance, etc.), databases, and ecological models that are available to the public for the US and insular areas.

<http://www.landfire.gov/>

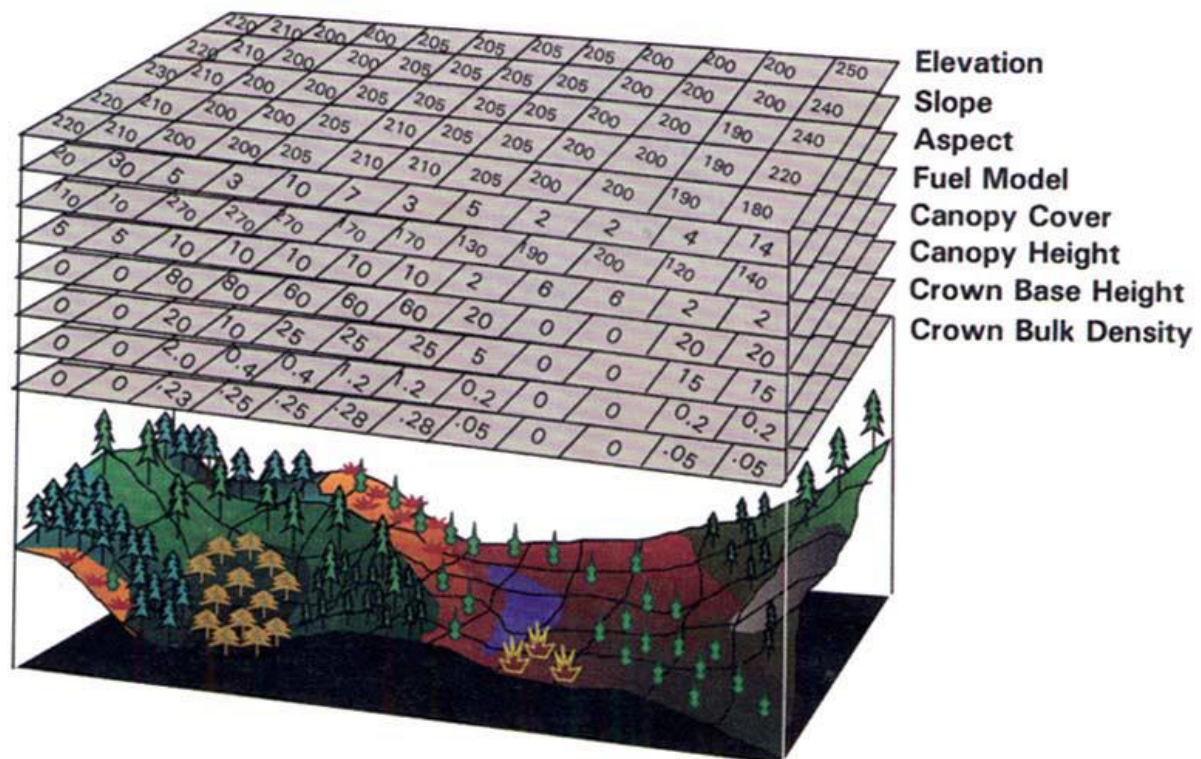


Figure 1. Raster landscape input layers that make up the Landscape (LCP) file.

Mechanical and prescribed fire treatments are being proposed as methods to restore aspen on Monroe Mountain. In order to model the effects these treatments would have on fire behavior, post-treatment vegetation condition needed to be described in terms of fuel models and canopy characteristics. With the help of personnel from the Missoula Fire Lab in Montana, the table below (Table 1) was created to describe the post-treatment fuel conditions based on vegetation type and treatment type. These values were then substituted into the LCP file for the treatment areas to give a post-treatment landscape.

		LANDFIRE	Post-Treatment				
Vegetation	Treatment	Fuel Model	Fuel Model	Stand_Ht	Canopy Bulk Density	Crown Base Height	Canopy Cover
Aspen	All Con	165, 161	161	15 m	0.01	10 m	45
Aspen	Up to 8"	165, 161	161	18 m	0.03	1.5 m	55
MC	Up to 8"	165, 183	185	18 m	0.09	1.5 m	55
MC	90 BA	165, 183	183	18 m	0.04	0.5 m	45
S-F	Up to 8"	165, 183	185	18 m	0.09	1.5 m	55
S-F	90 BA	165, 183	183	18 m	0.04	0.5 m	45

Aspen	Burn	165, 161	181	0	0	0	0
MC	Burn	165, 183	183	18 m	0.06	10 m	25
S-F	Burn	165, 183	183	18 m	0.07	10 m	25

Table 1: Description of post-treatment fuel and canopy characteristics

Modeling

With the necessary inputs created, FlamMap was used to calculate Flame Lengths, Crown/Surface Fire Activity, and Spotting Distance. FlamMap is a fire behavior mapping and analysis program that computes potential fire behavior characteristics over an entire Landscape (LCP) file for constant weather and fuel moisture conditions (Finney, 2004).

The FlamMap software creates raster maps of potential fire behavior characteristics. The raster maps can be viewed in FlamMap or exported for use in a GIS, image, or word processor. There is no temporal component in FlamMap. It uses spatial information on topography and fuels to calculate fire behavior characteristics for a single set of environmental conditions. FlamMap is widely used by the U.S. Forest Service, National Park Service, and other federal and state land management agencies in support of fire management activities.

It uses the same spatial and tabular data as *FARSITE*:

- Landscape (.LCP) file,
- Initial Fuel Moistures (.FMS) file,
- optional Custom Fuel Model (.FMD) files,
- optional Conversion (.CNV) files,
- optional Weather (.WTR) files, and
- optional Wind (.WND) files.

It incorporates the following fire behavior models:

- Rothermel's (1972) surface fire spread model,
- Van Wagner's (1977) crown fire initiation model,
- Rothermel's (1991) crown fire spread model, and
- Nelson's (2000) dead fuel moisture model.

FlamMap runs under Microsoft® Windows operating systems and features a graphical user interface. Users may need the support of a geographic information system (GIS) analyst to use FlamMap because it requires spatial coincident landscape raster information to run.

FlamMap assumptions and limitations

Since FlamMap uses the same underlying models (Rothermel's 1972, 1991, Van Wagner's 1977, and Nelson's 2000) for surface fire spread, crown fire spread, and dead fuel moisture, it will inherently have the same assumptions and limitations as each of those models. In addition, FlamMap 5.0 has a number of additional limitations:

- Modeling results assume that all mechanical treatments occurred in 2015, and prescribed fires occurred across all areas proposed for treatment in 2015. In reality, the treatments would be spread out over the life of the project. This means that desired conditions across the entire landscape may not occur concurrently.
- All fire behavior calculations in FlamMap Basic assume that fuel moisture, wind speed, and wind direction are constant for the simulation period.
- The fire behavior calculations are performed independently for each cell on the gridded landscape.
- Flammap does not use a 24 hour clock, so diurnal weather changes, which could affect fire behavior, are not accounted for.
- Canopy characteristic in the Landfire data were adjusted based on Table 1 data to represent post-treatment conditions.

FlamMap runs were made based on weather from June 30 to July 2, 2012. There were several large fires across the State of Utah at that time, so it is very likely that if ignited, a fire would have burned and gotten large on Monroe Mountain. Some of the fires burning in Utah during or around this time period included the Church Camp Fire (7,200 acres), Clay Springs Fire (108,000 acres), Dump Fire (5,500 acres), Grease Fire (16,500 acres), New Harmony Fire (1,957 acres), Pole Creek Fire (2,000 acres), Quail Fire (2,200 acres), Seeley Fire (47,600 acres), Shingle Fire (8,200 acres), Wolf Den Fire (19,900 acres), and the Wood Hollow Fire (47,400 acres). The actual weather observations came from the Signal Peak RAWS on Monroe Mountain and were used to "condition" the model. Since only a single wind speed and

direction can be used, a value of 15 mph from the southwest was chosen based on the predominate winds for that time of year and the FARSITE calibration.

Fuel Moistures, which is the weight of the water in the plant material divided by the oven dry weight of the plant material, are from sampled values near the Signal Peak RAWS. The samples were taken on June 28, 2012. The 10 hr (sticks ¼- 1" diameter) measured 5%, the 100 hr (sticks 1-3" diameter) measured 5%, and the 1000 hr (sticks 3+" diameter) measured 7 %. For live fuel moistures, juniper measured 89%, and douglas fir measured 101%. These values can be seen at:

http://www.wfas.net/nfmd/public/gacc_map.php?gacc=EGBC

TheFlamMap model was run, and outputs recorded for the No-Action, and four treatment alternatives.

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Fire Ecology, Fire and Fuels

Monroe Mountain Aspen Ecosystems Restoration Project

Appendix PFC: Properly Functioning Condition

Appendix PFC

PROPERLY FUNCTIONING CONDITION

January 7, 2000 Version

RAPID ASSESSMENT PROCESS**I. BACKGROUND**

A team was assigned in early 1996 by the Intermountain Regional Office Directors to "Establish a process, including criteria and indicators, which will allow identification of areas not currently in a properly functioning condition" [PFC] (see Appendix A). Besides the assigned team; Steve Munson, Entomologist, Ogden Field Office, was recruited for consultation in developing criteria and indicators. Expectations and timelines for the phase one effort are in Appendix A.

This report is a compilation of three different activities. First is the outline of the process of assessing Proper Functioning Condition.

Second is an example of application of the process at the Intermountain Region scale and third is an example of the application of the process at a sub-regional scale.

Subsequently, some forests and districts have been applying the process at a landscape scale. No examples of the latter applications are included at this time.

The PFC process and assessments fit within an ecological approach to management and within the concept of "Continuous Assessments and Planning".

The process and assessments herein are in draft form as refinements and corrections are made as experience and understanding accumulates. This document should be viewed more as a "work in progress" than a completed event.

This version includes some changes in soil cover that were first sent out in a File Code 2000 letter on August 21, 1997 under the Director of Vegetation Management's signature.

II. CONCEPTS AND DEFINITIONS

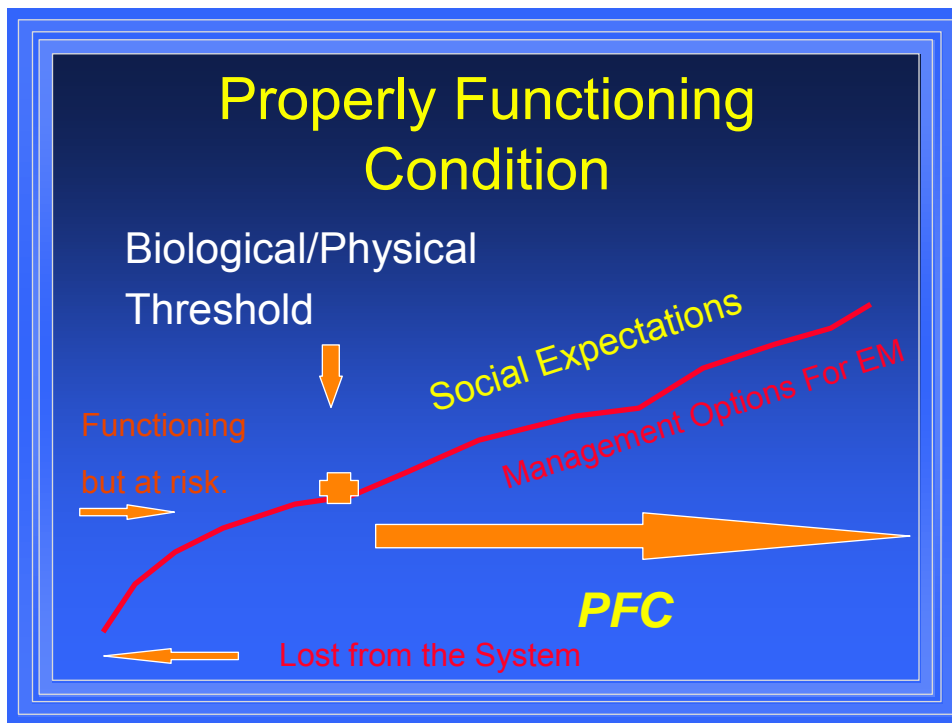
This process was developed using concepts of Proper Functioning Condition as described in the Bureau of Land Management publication: TR 1737-9, 1993, "Riparian Area Management, Process for Assessing Proper Functioning Condition" 52 pages by Barrett and others, (1993). The Intermountain Region team was charged with taking the site specific BLM concept and process and apply it to larger scales and to upland conditions. Terminology follows Barrett and others, (1993). Other terms that have essentially the same meaning include "ecosystem integrity", "ecosystem resiliency", and some uses of the term "biodiversity". Each of these terms describes ecosystem states or conditions. Ecosystem states or conditions are intrinsic to the ecosystem in question and can be measured and described. Other terms that are related but not identical to PFC, integrity or resiliency include "ecosystem health", "forest health", and "rangeland health". These terms better describe a condition relative to some capability of an ecosystem to reach certain goals or objectives as it is self-evident that what is "healthy" for one system may be considered "unhealthy" in another. "Health" is not an intrinsic characteristic of ecosystems but is a relative measure of whether ecosystem conditions can reach desired objectives. (Much of the preceding discussion is adapted from MacCleery, 1997).

It must be emphasized that PFC is a rapid assessment process and is a part of a greater whole. This greater whole is termed "Taking an Ecological Approach". The less precise term of "Ecosystem Management" is used by many as it is shorter than the phrase "taking an ecological approach". Much of the philosophical foundation for an ecological approach and the Intermountain Region PFC process is given in Kaufmann and others, (1994).

Definitions of PFC and "Risk" were developed by the team to guide process development and to identify systems at risk of not being in PFC. (It is important to remember that PFC is limited to biological and physical conditions and does not reflect potential management strategies.)

Properly Functioning Condition - Ecosystems at any temporal or spatial scale are in a properly functioning condition when they are dynamic and resilient to perturbations to structure, composition, and processes of their biological or physical components.

Risk - Risk refers to situations in which the outcome is not certain, but the chance of system degradation beyond the point of resiliency and sustainability can be estimated.



III. ECOLOGICAL APPROACH

All PFC assessments should use an ecological approach. An ecological approach requires consideration of three spheres {termed "ecological capabilities" and "social and economic needs" by Kaufmann and others, (1994).} 1. biological and physical (bio-physical), 2. social, and 3. economic. Although PFC works mainly within the bio-physical sphere there is significant relevance to the social and economic spheres. For example:

The Forest Service is charged by laws to maintain certain standards such as clean water, clean air, endangered species and soil conservation while at the same time is directed to provide for a variety of goods and services. These laws not only reflect the biological and physical needs for land

stewardship but in large part the social expectations of the public. Using an ecological approach requires that each sphere be characterized before synthesizing all three into a sustainable range of choices to complete the entire assessment phase. All possible choices should provide for a PFC of the biological and physical sphere and allow management to implement sustainable proposals that move ecosystems toward their potential. PFC is a description of a particular ecosystem state or condition but it is not the same as a desired future condition (DFC). PFC deals with sustaining intrinsic ecosystem structures, compositions, processes and patterns at a level that is judged to be sustainable according to our current understanding. DFC may or may not meet PFC after all social values are included. DFC's are an out come of the entire ecological approach and include social values.

PFC is a "coarse filter approach". The assumption is that if vegetative communities and their processes are similar today to those that occurred historically, then conditions approximate those under which species evolved. Presumably, therefore, the full complement of species will persist. Kaufmann and others (1994) put it in these words:

"Our working assumption is that naturally evolving ecosystems (minimally influenced by humans) were diverse and resilient, and that within the framework of competition, evolutionary pressure, and changing climates, these ecosystems were sustainable in a broad sense. Many present ecosystems modified by modern industrial civilizations do not have all these characteristics. Our guiding premise for sustaining ecosystems and protecting biodiversity now and into the future is to manage ecosystems such that structure, composition and function of all elements; including their frequency, distribution, and natural extinction, are conserved. Conservation focuses on maintaining and restoring suitable amounts of representative habitats over the landscape and through time."

The PFC assessment process is a coarse filter approach to ecosystem sustainability. The most basic concept inherent in an ecological approach and in PFC is sustainability. The international agreement on temperate and boreal forests known as "The Montreal Process" (Canadian Forest Service, 1995) contains 7 criteria and a larger suite of indicators of sustainable forests. The Criteria are:

1. Conservation of biological diversity
2. Maintenance of productive capacity of forest ecosystems
3. Maintenance of forest ecosystems health and vitality
4. Conservation and maintenance of soil and water resources
5. Maintenance of forest contribution to global carbon cycles
6. Maintenance and enhancement of long-term multiple socio-economic benefits to meet the needs of societies
7. Legal, institutional and economic framework for forest conservation and sustainable management

If the Indicators of the Montreal process are examined; the PFC process is closely aligned with at least 6 of 8 indicators under Criterion 1; 1 of 5 of Criterion 2; 2 of 3 of Criterion 3; 5 of 8 of Criterion 4; and 1 of 3 of Criterion 5. The Regional PFC process recognizes the importance of Criterion 6, but our charter specifically excluded it at the time. Criterion 7 of the Montreal Process was taken as a given in the Regional PFC document.

PFC does not deal directly with fine filter considerations in ecological assessments because it is a coarse filter for rapid assessments for "areas not currently in a properly function condition". It **should not** be used by itself as a decision making process but rather it is an assessment process adapted to the decision making processes of the National Environmental Policy Act (PL-91-190) of 1970. PFC fits within the planning framework and regulations of the National Forest Management Act of 1976 (PL-94-588).

IV. PROCESS

A. Design

The design includes three scales: Regional; Sub-Regional; and Landscape. These scales are directly related to the Forest Service National Hierarchical Framework of Ecological Units developed under a policy of ecosystem management adopted by USDA Forest Service June 4, 1992. Planning and analysis scales were used instead of the hierarchical framework scales for simplicity and because PFC is a planning assessment. Use of any planning and analysis scales for assessments should include full consideration of the ecological units within the hierarchical framework. Refer to Exhibit A for an overview of how the two systems are related. The publication "Ecological Subregions of the United States: Section Descriptions" dated July 1994 is a valuable reference for any assessments.

Basic characteristics of ecosystems include 1. Structure, 2. Composition, 3. Processes, 4. Patterns. A matrix with these four characteristics as criteria and at three scales (See Exhibit B), was developed to assess PFC. The matrix is used to describe each individual subject area to be assessed. At the scale of the Intermountain Region the subject areas include sixteen vegetation types, a hydrologic regime, a soil quality description, and an aquatic and terrestrial animal description. Indicators of a properly functioning condition were developed for each subject area, by criteria, and at each scale.

Criteria in the matrix are structure, composition, disturbance regime (a surrogate for more basic ecosystem processes), and patterns.

Structure is a means to express the balance of age and size classes for included subject areas related to vegetation types. A defined balance of size classes was estimated to reflect one that would sustain the type in the long term. Simply this means there must be adequate recruitment in the type to sustain a range of age classes. For many of the conifer types the selected range of classes includes: 10 percent Grass/Forb; 10 percent Seedling/Sapling; 20 percent Young Forest; 20 percent Mid Aged Forest; 20 percent Mature Forest; and 20 percent Old Forest. These percentages are estimates or approximations and are not presented as absolute values but are suggested general proportions. The basis for using these vegetative structural stages comes from the work done by Reynolds and others, (1992). They recommended this mixture of classes because it sustained both forest cover types and a large suite of wildlife species. There are exceptions but in general if these relative proportions are sought most of the wildlife and social needs in forested landscapes can be met. For other subject areas such as non conifers, non forest types, riparian/wetlands, soil quality, hydrologic regime, and aquatic and terrestrial animals, structure is expected to reflect a balance not exceeding the sustainable biological and physical capabilities of the resource. The indicators for these subject areas are based on the experience and education of the team members and the knowledge of the scientific studies.

Composition is an expression of species present in each of the subject areas. For vegetation and fauna this includes the dominant species. In the case of vegetation it means the recruitment and sustainability of early seral species while still providing the diversity of all successional species (flora and fauna). In many of the forest, shrub or woodland subject areas this requires a lower cover by mature plants to allow development of associated species such as grasses, forbs, and shrubs to limit the amount of bare soil.

Disturbance regime was used to characterize processes and ecological functions. It includes all known historical disturbances that have effected the ecosystems. These include past grazing, human trampling, logging, foraging by ungulate wildlife, wind, flood, insects, diseases, and fire. Each ecosystem or biome differs in which disturbance factors are or have been most active. The most common factors are fire, insects and disease. For each ecosystem the historical fire regime was described in terms of lethal and not lethal fire intensities and frequencies. This was based on available sources of information from published research and recorded histories. Insect and disease conditions were based on current and past aerial surveys for the ecosystem and the known scientific work and experience. More fundamental ecosystem processes and functions such as carbon balances, nutrient and energy cycles, etc. are more difficult and costly to ascertain at broad scales so disturbance regimes were used as a more easily observed surrogate.

Patterns are an indication of how ecosystems function among and between themselves. Criteria addressed the size, shape, age class, distribution, and juxtaposition of structures and composition in and adjacent to each ecosystem. Patterns are evaluated by comparison to their historical ranges (e.g. 100-500 years before present times). Changes between ecosystems such as juniper movement into big sagebrush/grass, and conifer succession into aspen were not the primary objective of the criteria but are part of the consideration of changes in patterns if a type had lost area or gained area.

Ecosystems vary in time and space. Changes may be rapid or gradual but change occurs. The term "historical range of variation" (some authors use "historic" rather than "historical") refers to ecosystem compositions, structures, processes and patterns for a specified time and for a specific area. Ecosystems have the capacity to change drastically over short or long periods of time and from place to place. As a result, ecosystem components and processes are adapted to a range of conditions. It is believed that native species adapted to and, in part, evolved with the disturbance events of the preceding several thousand years. This provided patterns of landscape and ecosystem variation that were apparently self-sustaining. Successive generations of the same biota under the same conditions give the best indication of sustainability. The potential for survival of native species is reduced if their environment is pushed outside the range of natural variation.

The range of historical variation includes any processes or patterns, which may or probably could have occurred on a given landscape over time for the time period considered. The definition, as employed, is relatively narrow and emphasizes those processes that tended to occur in cycles and had a more or less predictable frequency. Examples include cycles of drought, fire incidence and population fluctuations in biota. Large scale stochastic events may be instrumental in defining large patterns on the landscape, e.g. windstorms, massive floods, landslides caused by earthquakes, volcanic eruptions, etc., but these events are not normally amenable to any management activities. Such events may be part of an expanded concept of historical range. For example, the range of historical variation for an area would include evidences of the light to moderate intensity fires, which swept through an open ponderosa pine savanna every 7 to 12 years over a 100 year period. The range of historical variation would not usually include an event, which occurred once in 500+ years when an intense fire combined with an intense rainstorm produced massive amounts of sediment on the same area. That possibility may be described, but is not usually included in the general definition of range of historical variation for that particular area (extreme events versus more normal, reoccurring events).

Reference conditions are used to help establish the historical range of variation. Kaufmann and others, (1998) have a good discussion of reference conditions for vegetation.

Reference and existing conditions are both moving targets, however, because vegetation is constantly changing. Thus reference conditions are not useful for providing detailed maps and descriptions of geographically specific patterns in the landscape that can or should be restored to their historic condition. Rather, reference conditions help determine characteristics such as the amount and kinds of heterogeneity in spatial patterns that existed before significant human impact occurred, and the natural disturbance patterns and conditions that created these patterns over time. This

knowledge can provide a basis for evaluating existing conditions and identifying places in the landscape where management activities might efficiently bring current forests into alignment with historic landscape features. Reference conditions can help clarify which management activities work in the direction of improving ecosystems sustainability and which ones might further exacerbate ecosystem unsustainability. (Kaufmann and others, 1998, p. 5)

In the western states, conditions present prior to European settlement are often used as the reference condition to indicate the historical range of variability. Conditions at that time are more readily determined than those of earlier times and many biotic and abiotic elements are continuous from then to the present (e.g. many individual plants may remain and most land forms are the same or little changed). Generally, 100 to 500 years prior to the present is the most commonly employed time frame.

There are problems with the selection of any time period used as the reference condition and these must be kept in mind. For example, the reference period just prior to European settlement occurred at a time when Native American populations were much lower than in previous centuries because of the large numbers of Native Americans who fell victim to European diseases. It is difficult to measure or even estimate the impact of Native American populations on ecosystems because these are rarely recorded or separable from other processes. More or less concurrent with the great reductions in Native American populations was a major shift in climate. The large-scale climatic pattern known as the "Little Ice Age" occurred from about 1550 to around 1860 (other references put it from about 1350 to 1870). Much of the European settlement was at the end of or just after the Little Ice Age so it is difficult to separate changes in biota caused by European settlement from changes driven mainly by climate change or changes driven by the cessation of Native American cultural practices.

Threshold ranges or values are suggested to establish acceptable ranges of PFC to provide for ecosystem sustainability and resiliency. Thresholds were developed by considering all of the factors in a holistic and ecologically based synthesis of the structure, composition and processes in a given biome and comparing the current pattern to historical patterns.

SUBJECT AREAS:

- Alpine
- Subalpine timberline forests and woodlands
- Engelmann spruce - subalpine fir
- Quaking aspen
- Lodgepole pine
- Grand fir/white fir complex
- Interior Douglas-fir
- Ponderosa pine/Jeffrey pine complex
- Ponderosa pine Southern Utah type
- Pinyon - Juniper
- Mountain mahogany
- Gambel oak
- Tall Forb
- Mountain brush complex
- Big sagebrush/Grasslands
- Hydrologic regime
- Soil quality
- Riparian/wetlands
- Aquatic and terrestrial animals -

To assist the assessment process a "Standard Checklist" (Exhibit C) was created for an assessment team's use. In addition the Standard Checklist for Riparian/Wetlands (Exhibit D) developed by the

Bureau Of Land Management should be used specifically for site specific assessments in the riparian/wetlands subject area. These checklists provide a place to initiate discussion and a systematic way to help conduct the assessment.

B. Assessment Process

1. Define scale of assessment both temporal and spatial.
2. Assemble team of technical experts for scale(s) being considered.
3. Utilize the appropriate matrices by subject area to determine kinds of resource information needed and available.
4. Select the appropriate subject areas and by evaluating all of the criteria together to make a considered determination if the subject area is: non-functional; or functional - at risk; or within proper functioning condition.

Step 5 is optional. Some teams may want to make the risk assessment in step 5. Others may be uncomfortable with assigning a risk value. We have found the risk assessment useful as a relative ranking procedure. It is a team decision whether or not to assign a risk category.

5. If subject area(s) are not in (PFC) estimate the degree of departure or risk (e.g. low, medium or high) from PFC.
6. Summarize the results for the selected geographical and temporal scale(s).

The PFC process is similar to other assessment processes and a review of the steps above shows that much is simply common sense. It is adapted to a variety of scales and helps set the biophysical context for planning activities and it fits well with current laws and policies. It is rapid, cost effective, robust, understandable and useful, if applied as designed. Because it is rapid and cost effective it can be redone if more information becomes available. Thus a PFC assessment can be dynamic, adaptable and easily updated as conditions and understanding change.

EXHIBIT A: Adapted from the introduction in: "Ecological Subregions of the United States: Section Descriptions". Compiled by W. Henry McNab and Peter E. Avers. July 1994. United States Department of Agriculture, Forest Service, Ecosystem Management, Washington, DC.

Planning and analysis scale	Ecological units	Purpose, objectives and general use	General size range	
Ecoregion				
Global	Domain	Broad applicability for modeling and sampling, strategic planning and assessments and international planning.	Millions to tens of thousands of square miles	

Continental	Division		Thousands to tens of square miles	

Regional	Province			
Subregion	Section	Strategic, multi-forest, statewide and multi-agency analysis and assessment	Thousands to hundreds of acres	
	-----	Forest, area-wide planning and watershed analysis		
Landscape	Subsection	Hundreds to less than ten acres		
	Landtype association		Project and management area planning and analysis	
Land unit	Landtype			

	Landtype phase			

(From: Ecological Subregions of the United States: Section Descriptions. USDA Forest Service, Ecosystem Management, July, 1994. WO-WSA-5.)

EXHIBIT B: Matrix used to assess major subject areas.

SUBJECT:	INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)		
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>			
<u>COMPOSITION</u>			
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)			
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)			

EXHIBIT C: STANDARD CHECKLIST (All subject areas except Riparian/Wetlands)**Subject Area****Name:** _____**Date:** _____ **ID Team Members:** _____**Yes No N/A****SOIL/HYDROLOGIC**

- (1). Surface litter, duff, plant residue and large woody debris is present in quantities sufficient to sustain soil productivity and nutrient cycling.
- (2). Ground cover is adequate to protect soils from eroding by overland flow.
- (3). Soil infiltration/percolation is adequate to prevent or reduce overland flow.
- (4). Water and sediment being supplied by the watershed to the stream is in balance with the stream's transport capability.
- (5). Vegetation provides adequate cover and soil binding properties to reduce erosion and encourage infiltration of water.

Yes No N/A**VEGETATIVE**

- (6). Structural classes diverse or balanced for sustainability or recovery.
- (7). Diverse composition of vegetation or preferred seral species.
- (8). Insect and disease populations at endemic levels.
- (9). Fire regimes within historical ranges.
- (10). Other disturbance regimes within historical ranges.
- (11). Patterns among and between subject areas consistent with historical ranges for ecological units.

Yes No N/A**AQUATIC AND TERRESTRIAL ANIMALS**

- (12). Age classes and reproductive cohorts of native amphibians, fish and (vertebrate and invertebrate) wildlife are present, and adequate to maintain sustainable populations within historical ranges.
- (13). Physical and biological habitat elements (communities, species, stages, morphology) are available within seasonal home ranges of native species.
- (14). Native fish, amphibian and wildlife species are present in sustainable populations in adapted habitats.
- (15). Historical predators, competitors, prey, and habitat modification processes are present, supporting species' viability and sustainability.
- (16). Exotic species, diseases, or human uses do not limit, displace, or reduce viability of native species.
- (17). Disturbances affect only small portions of animal's annual ranges. (Especially for small, sedentary species with limited movement.)
- (18). Animal populations exhibit genetic integrity and diversity, and successful reproductive interchange, without isolation, across historically occupied habitats. Migration, distribution and reproduction unhindered by habitat management or disturbance within historical ranges.

EXHIBIT D: STANDARD CHECKLIST

(Adapted from "Riparian Area Management - TR 1737-9, 1993. BLM, pp. 41-42)

Name of Riparian-Wetland

Area: _____

Date: _____ Area/Segment ID: _____ Miles _____

ID Team Observers: _____

Yes	No	N/A	HYDROLOGIC
			1) Floodplain inundated in "relatively frequent" events (1-3 years)
			2) Active/stable beaver dams
			3) Sinuosity, width/depth ration, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
			4) Riparian zone is widening or has achieved potential extent
			5) Upland watershed not contributing to riparian degradation

Yes	No	N/A	VEGETATIVE
			6) Diverse age-class distribution (recruitment for maintenance/recovery)
			7) Diverse composition of vegetation (for maintenance/recovery)
			8) Species present indicate maintenance of riparian soil moisture characteristics
			9) Streambank vegetation is comprised of those plants or plant communities that have root masses capable of withstanding high streamflow events
			10) Riparian plants exhibit high vigor
			11) Adequate vegetative cover resented to protect banks and dissipate energy during high flows
			12) Plant communities in the riparian area are an adequate source of coarse and/or large woody debris

Yes	No	N/A	SOILS-EROSION DEPOSITION
			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody debris) adequate to dissipate energy
			14) Point bars are revegetating
			15) Lateral stream movement is associated with natural sinuosity
			16) System is vertically stable
			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

(Revised 1995)

[illegible]

Proper Functioning Condition	_____
Functional--At Risk	_____
Nonfunctional	_____
Unknown	_____

Upward _____
Downward _____
Not Apparent _____

Yes _____
No _____

☐ Flow regulations ☐ Mining activities ☐ Upstream channel conditions
☐ Channalization ☐ Road encroachment ☐ Oil field water discharge
☐ Augmented flows ☐ Other (specify) _____

APPENDIX A:

CHARTER TO TEAM AND TEAM MEMBERS

In late February and early March of 1996, the Regional Forester for the Intermountain Region developed a list of Ecosystem Management Expectations and priorities. The first priority on the list was stated as:

In total, our management actions are designed to ensure the public's riparian areas, rangelands and forest are in a "properly functioning condition."

As part of this priority setting and direction a meeting was called by the Board of Directors on March 8, 1996 and a team assembled. The following written direction was given the team:

Tasks Related to Identifying
Properly Functioning Condition

Phase One - Identification: Establish a process, including criteria and indicators, which will allow identification of areas that are not currently in a PFC.

Phase Two - Evaluation: Establish procedures which assure appropriate identification and evaluation of risks, costs, and benefits.

Phase Three - Decision Phase: Define organizational strategy which allows strategic decisions to be made resulting in establishing priority for treatment across time.

Phase Four - Implementation Phase: While conducted by Forest/Eco-Groups, there is a critical need to assure that budget, training, and policy and procedural direction or guidance enables this phase.

Phase Five - Monitoring Phase: Monitoring Phase - Monitoring would be conducted at various scales to determine how well we are performing in increasing and maintaining the acreage of National Forest System land that is in a properly functioning condition.

The Board of Directors selected a team with Jack Amundson as team leader.

Team Leader:

Jack Amundson, Regional Silviculturist.

Members:

Karen Ogle, Fire Ecologist, Boise National Forest.
Alma H. Winward, Regional Ecologist.
Peter J. Stender, Regional Hydrologist.
David A. Newhouse, Regional Wildlife Ecologist.
Thomas M. Collins, Regional Soil Scientist.
Kris Lee, Regional Fisheries Program Manager
David M. Neeley, Transportation Systems Engineer.

Jack Amundson requested that Clinton K. Williams be added to the team and it was done.

The Board of Directors gave the following Expectations and Timeline:

- To expand the concepts developed for the riparian areas as defined by Wayne Elmore, BLM, and transfer in a holistic manner to the uplands.

- At Phase One, the team is charged to identify a process, establish criterion, and test this methodology in one or more areas.
- We expect that a draft of the process is developed by April 1 and presented to the Resource Directors and representative for Forest Service Research for review and comment.
- By May 1, we expect a final draft of the process including criteria for identification.
- At the May Leadership Team Meeting, we expect this team would present its final product and elicit Forest volunteers for testing.
- After test phase is completed (1 month), we expect a final product for decision.
- In that this team is charged with only Phase One, and we see need for another team to develop Phase Two, we expect this team to share information and embrace Team Two and its objectives.

APPENDIX B:

SUBJECT AREAS

SUBJECT: <u>ALPINE</u>		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Characterized by a lack of arboreal vegetation, landscape dominated by shallow soils, fell-fields, boulders, tundra and turf-forming vegetation with some areas with low shrubs. (e.g. <1 ft. tall.)	Characterized by a lack of arboreal vegetation, landscape dominated by shallow soils, fell-fields, boulders, tundra and turf-forming vegetation with some areas with low shrubs. (e.g. <1 ft. tall.)	Characterized by a lack of arboreal vegetation, landscape dominated by shallow soils, fell-fields, boulders, tundra and turf-forming vegetation with some areas with low shrubs. (e.g. <1 ft. tall.)
<u>COMPOSITION</u>	Dominated by native, perennial plant species. Indicator lichens and bryophytes are within historical ranges.	Native perennial plant cover <input type="checkbox"/> 50%. Indicator lichens and bryophytes are within historical ranges.	Bare ground < 15%. Indicator lichens and bryophytes are within historical ranges.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Trampling, treading and herbivory are within historical ranges. Hydrologic regime within historical ranges.	Trampling, treading and herbivory are within historical ranges. Catchment, storage and release of water within historical ranges.	Trampling, treading and herbivory are within historical ranges. Catchment, storage and release of water within historical ranges.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Pattern of rocks, boulder fields and alpine plant communities within historical ranges.	Boulder fields, alpine turf and meadows within historical ranges.	Boulder fields, alpine turf and meadows within historical ranges.

SUBJECT: SUBALPINE TIMBERLINE FORESTS (primarily dominated by 5-needle pines)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structures, sizes and age classes. 20-40% of acres have trees greater than 10 feet tall and 80 or more years of age.	Balanced range of structures, sizes and age classes. 20-40% of acres have trees greater than 10 feet tall and 80 or more years of age.	Balanced Range: Grass/forb, seedlings and saplings <input type="checkbox"/> 10-20%* Young, Mid Aged and mature forest <input type="checkbox"/> 30-50%* Old Forest <input type="checkbox"/> 20-40%* [Basal areas typically are less than 100 square feet and SDI is less than 100.] (* indicates proportion of acres)
<u>COMPOSITION</u>	More than 70 % of trees are 5 needle pines (e.g. whitebark, limber or bristlecone) and less than 20% of trees are spruce, true firs or Douglas-fir.	More than 70 % of trees are 5 needle pines (e.g. whitebark, limber or bristlecone) and less than 20% of trees are spruce, true firs or Douglas-fir.	More than 70 % of trees are 5 needle pines (e.g. whitebark, limber or bristlecone) and less than 20% of trees are spruce, true firs or Douglas-fir.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic levels of insect and disease activity are present. Less than 10% of acres have white pine blister rust present. Fire regime is mixed severity with a 100-150 year interval between stand-replacing fires.	Endemic levels of insect and disease activity are present. Less than 10% of acres have white pine blister rust present. Fire regime is mixed severity with a 100-150 year interval between stand-replacing fires.	Endemic levels of insect and disease activity are present. Pockets of mortality do not exceed groups of 5 trees per acre. Aerial detection surveys indicate mortality does not occur in groups exceeding 10 trees. Less than 10% of the 5 needle pine trees have white pine blister rust present. Fire regime is mixed severity with a 100-150 year interval between stand-replacing fires and 50-70 years between surface fires.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Open forests to woodlands, canopies do not close and trees are distributed in sparse stands or widely spaced clumps of trees.	Open forests to woodlands, canopies do not close and trees are distributed in sparse stands or widely spaced clumps of trees.	Open forests to woodlands, canopies do not close and trees are distributed in sparse stands or widely spaced clumps of trees.

SUBJECT: ENGELMANN SPRUCE - SUBALPINE FIR (<i>Picea engelmannii</i> - <i>Abies lasiocarpa</i>)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages.	40% is Mature and Old.	<p>Balanced Range:</p> <p>Grass/forb <input type="checkbox"/> 10%</p> <p>Seedling/Sapling <input type="checkbox"/> 10%</p> <p>Young Forest <input type="checkbox"/> 20%</p> <p>Mid Aged Forest <input type="checkbox"/> 20%</p> <p>Mature Forest <input type="checkbox"/> 20%</p> <p>Old Forest <input type="checkbox"/> 20%</p> <p>40% of the stands have multiple canopies. Stand Density Index (SDI) not greater than 335 and Basal Area less than 150.</p>
<u>COMPOSITION</u>	Engelmann spruce is dominant.	More than 40% of trees are Engelmann spruce.	More than 40% of trees are Engelmann spruce.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insect and disease populations. <10% of the host type has root disease centers. Fire regimes are within historical ranges. Lethal fire regime on a 100 to 300 year cycle.	Endemic insect and disease populations. Insect and disease activity in groups of <50 trees. Fire regimes are within historical ranges. Lethal fire regime on a 100 to 300 year cycle.	<p>Endemic insect and disease populations. No defoliation of >50% of crown is observed. Mortality in groups of <5 or more trees per acre.</p> <p>Avalanche, windthrow or landslides do not affect more than 2% of the spruce trees 10 inches or greater d.b.h. < 5% of acres in root disease centers. Fire regimes are within historical ranges. Mixed severity and lethal fire regimes. Mixed severity regime on a 50 to 80 year cycle and lethal regime on a 100 to 300 year cycle.</p>
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns are within historical ranges. The role of fire is to influence species distribution and age classes.	Patterns are within historical ranges. (corridors present and functional.) The role of fire is to influence the distribution of structure classes, composition, and pattern across the subregion.	Patterns are within historical ranges. (Pattern sizes, shapes and corridors are maintaining processes.) The role of fire is to maintain a heterogenous pattern of species and structure classes. A mixed severity fire regime produces vegetation mosaics due to patchy nature of the fire, preventing development of large continuous blocks of homogenous ages and species.

SUBJECT: ASPEN (<i>Populus tremuloides</i>)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages.	30% is Mature and Old age classes.	Balanced Range: Grass/forb and regeneration and saplings □ 40% Young, Mid Aged and mature forest □ 30% Old Forest □ 30%
<u>COMPOSITION</u>	Aspen is dominant. Less than 15% of area is succeeding to other cover types. Shrub and herbaceous layers well developed.	Conifer encroachment is minimal (e.g. Conifer composition not more than 15% cover in stands.) Shrub and herbaceous layers well developed.	Stand Density Index (SDI) not greater than 300 and Basal Area less than 140. Mature and Old Forest aspen less than 150 years old. Conifer composition not more than 15% cover in stands. Shrub and herbaceous layers well developed. Ground cover at least 85% .
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insect and disease populations. Insect activity affects 20% or less of type. Fire regimes are within historical ranges. The fire regime is a lethal fire regime burning on a 20 to 100 year cycle.	Endemic insect and disease populations. <10% of clones with root disease. Tree mortality <10% in mature and old age classes. Fire regimes are within historical ranges. The fire regime is a lethal fire regime burning on a 20 to 100 year cycle.	Endemic populations of insects and disease. <30% topkill and branch mortality in mature and old age classes. A fire interval of 20 to 50 years generally occurs in seral stands. Low to moderate intensity surface fires slow conifer encroachment. Intervals that approach 100 years are typical of climax aspen stands that don't require frequent disturbance to perpetuate the clone.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns are within historical ranges. The role of fire is to maintain presence of aspen.	Patterns are within historical ranges. (corridors are present and functional.) The role of fire is to influence distribution of structural classes and patterns across the subregion.	Patterns are within historical ranges. (Pattern sizes, shapes and corridors are maintaining processes.) The role of fire is to influence distribution of structural classes and patterns across landscapes.

SUBJECT: <u>LODGEPOLE PINE</u> (<i>Pinus contorta</i>)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages.	40% is Mature and Old.	Balanced Range: Grass/forb <input type="checkbox"/> 10% Seedling/Sapling <input type="checkbox"/> 10% Young Forest <input type="checkbox"/> 20% Mid Aged Forest <input type="checkbox"/> 20% Mature Forest <input type="checkbox"/> 20% Old Forest <input type="checkbox"/> 20% 20% of the stands have multiple canopies. Stand Density Index (SDI) not greater than 350 and Basal Area less than 90 sq. ft.
<u>COMPOSITION</u>	Lodgepole pine is dominant.	More than 80% of the trees are lodgepole pine.	More than 80% of trees are lodgepole pine
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insect and disease populations. Fire regimes are within historical ranges. The fire regime is lethal. Fires occur every 150 to 300 years.	Endemic insect and disease populations. Fire regimes are within historical ranges. The fire regime is lethal. Fires occur every 150 to 300 years.	Endemic insect and disease populations. Fire regime is a combination of mixed severity and lethal. Persistent lodgepole stands are typically in the lethal fire regime. Fires burn every 150 to 300 years in the lethal regime.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns are within historical ranges. The role of fire is to maintain presence of lodgepole pine stands.	Patterns are within historical ranges. (corridors are present and functional.) The role of fire is to maintain presence of lodgepole pine stands.	Patterns are within historical ranges. (Pattern sizes, shapes and corridors are maintaining processes.) Fire maintains a heterogenous pattern of age and size classes across the landscape.

SUBJECT: <u>GRAND FIR/WHITE FIR COMPLEX</u> (Assumed to be managed for seral species such as Douglas-fir, ponderosa pine or western larch)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages.	40% is Mature and Old.	Balanced Range: Grass/forb <input type="checkbox"/> 10% Seedling/Sapling <input type="checkbox"/> 10% Young Forest <input type="checkbox"/> 20% Mid Aged Forest <input type="checkbox"/> 20% Mature Forest <input type="checkbox"/> 20% Old Forest <input type="checkbox"/> 20% Not more than 50% of the stands have multiple canopies. Stand Density Index (SDI) not greater than 335 and Basal Area less than 180.
<u>COMPOSITION</u>	Ponderosa pine, western larch and Douglas-fir are dominant.	More than 75% is ponderosa pine, western larch and Douglas-fir	Grand fir/white fir composition is less than 25%.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insect and disease populations affect less than 5% of the host type. Fire regimes are within historical ranges. This is a nonlethal fire regime. The fire interval ranges from 10 to 60 years.	Endemic insect and disease populations affect 10% or less of host type. Pockets of mortality do not have more than 50 trees. Fire regimes are within historical ranges. The fire interval ranges from 10 to 40 years on dry sites. On more mesic sites the interval is longer (30 to 60 years).	Endemic insect and disease populations. No defoliation of more than 50% of the crowns. Mortality pockets not greater than 5 trees per acre with more than 10 trees in a group. Fire regimes are within historical ranges. The fire interval ranges from 10 to 40 years on dry sites. On more mesic sites the interval is longer (30 to 60 years).
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns are within historical ranges. The role of fire is to maintain seral stands of ponderosa pine/Douglas-fir/ western larch/ lodgepole pine with fir as a minor component.	Patterns are within historical ranges. (corridors are present and functional.) Fire maintains dominance of seral species with fir as a minor component.	Patterns are within historical ranges. (Pattern sizes, shapes and corridors are maintaining processes.) Fires of low to moderate severity favor open, seral stands of ponderosa pine, Douglas-fir and western larch and possibly lodgepole pine.

SUBJECT: INTERIOR DOUGLAS-FIR (<i>Pseudotsuga menziesii</i>)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages.	40% is Mature and Old.	<p>Balanced Range:</p> <p>Grass/forb <input type="checkbox"/> 10%</p> <p>Seedling/Sapling <input type="checkbox"/> 10%</p> <p>Young Forest <input type="checkbox"/> 20%</p> <p>Mid Aged Forest <input type="checkbox"/> 20%</p> <p>Mature Forest <input type="checkbox"/> 20%</p> <p>Old Forest <input type="checkbox"/> 20%</p> <p>Not more than 50% of the stands have multiple canopies. Stand Density Index (SDI) not greater than 298 and Basal Area less than 160.</p> <p>True fir composition is less than 25%.</p>
<u>COMPOSITION</u>	Ponderosa pine or Douglas-fir are dominant.	More than 75% is ponderosa pine or Douglas-fir.	
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insect and disease populations affecting 5% or less of the host type. Fire regimes are within historical ranges. This is a mixed severity fire regime with an interval of 10 to 50 years.	Endemic insect and disease populations affecting less than 10% of the host type and not over 25 trees in a mortality group. A nonlethal and mixed severity fire regime. On dry sites the interval ranges from 10 to 25 years and typically is a nonlethal surface fire. On cooler, wetter sites, the interval is longer (30 to 50 years) and fires burn under the mixed severity regime.	Endemic insect and disease populations with less than 50% crown defoliation. Mortality less than 5 trees per acre in groups of less than 10 trees. Less than 15% of acres with root disease centers. A nonlethal and mixed severity fire regime. On dry sites the interval ranges from 10 to 25 years and typically is a nonlethal surface fire. On cooler, wetter sites, the interval is longer (30 to 50 years) and fires burn under the mixed severity regime. Fires of low to moderate severity open dense stands of pole-sized or larger trees. Subsequent light burns maintain these stands in a park-like condition.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns are within historical ranges. Fire's role is to maintain Douglas-fir or ponderosa pine where they are seral species.	Patterns are within historical ranges. (corridors are present and functional.) Fire's role is to maintain Douglas-fir or ponderosa pine where they are seral species.	Patterns are within historical ranges. (Pattern sizes, shapes and corridors are maintaining processes.) Fire's role on dry and mesic sites is to prevent a shade tolerant understory from developing. Subsequent light burns maintain these stands in a park-like condition.

SUBJECT: PONDEROSA PINE/JEFFREY PINE COMPLEX (<i>Pinus ponderosa</i> , <i>Pinus jeffreyi</i>)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages.	20% is in grass/forb and seedling/sapling stages with 40% in Mature and Old stages.	Balanced Range: Grass/forb <input type="checkbox"/> 10% Seedling/Sapling <input type="checkbox"/> 10% Young Forest <input type="checkbox"/> 20% Mid Aged Forest <input type="checkbox"/> 20% Mature Forest <input type="checkbox"/> 20% Old Forest <input type="checkbox"/> 20%
<u>COMPOSITION</u>	Ponderosa or Jeffrey pine is dominant.	More than 75% is ponderosa or Jeffrey pine.	75% of multiple canopy structure is ponderosa or Jeffrey pine. Stand Density Index (SDI) not greater than 234 and Basal Area less than 140. More than 75% of trees are ponderosa or Jeffrey pine.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insect and disease populations. 5% or less of host type with insect activity and 30% or less of trees have dwarf mistletoe. Fire regime is a nonlethal type with a fire return interval of 5 to 25 years.	Endemic insect and disease populations. Tree mortality not over 10% of host type and mortality groups have less than 50 trees. <40% of trees have dwarf mistletoe; <10% with stem rust and root disease centers. Fire regime is a nonlethal type with a fire return interval of 5 to 25 years.	Endemic insect and disease populations. Pockets of mortality do not exceed 5 trees per acre. Mortality groups of <10 trees. <1% of trees with black stain, <10% with root disease, <20% with dwarf mistletoe or stem rust. Fire regime is a nonlethal type with a fire return interval of 5 to 25 years.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns are within historical ranges. The role of fire is to maintain both seral and climax stands of ponderosa pine or Jeffrey pine.	Patterns are within historical ranges. (corridors are present and functional.) The role of fire is to maintain both seral and climax stands of ponderosa or Jeffrey pine.	Patterns are within historical ranges. (Pattern sizes, shapes and corridors are maintaining processes.) The role of fire is to maintain open stands of pine by removing competing shade tolerant understory fir seedlings. Periodic fires can create uneven-aged stands comprised of groups of trees that vary in age from group to group.

SUBJECT: PONDEROSA PINE - SOUTHERN UTAH(Pinus ponderosa)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
STRUCTURE	Balanced range of structural stages.	20% is in grass/forb and seedling/sapling stages with 40% in Mature and Old stages.	Balanced Range: Grass/forb <input type="checkbox"/> 10% Seedling/Sapling <input type="checkbox"/> 10% Young Forest <input type="checkbox"/> 20% Mid Aged Forest <input type="checkbox"/> 20% Mature Forest <input type="checkbox"/> 20% Old Forest <input type="checkbox"/> 20% 75% of multiple canopy structure is ponderosa pine. Stand Density Index (SDI) not greater than 158 and Basal Area less than 120.
COMPOSITION	Ponderosa pine is dominant.	More than 75% is ponderosa pine.	More than 75% is ponderosa pine.
DISTURBANCE REGIME (e.g. fire, insects, pathogens, flood, wind)	Endemic insect and disease populations. 5% or less of host type with insect activity and 30% or less of trees have dwarf mistletoe. Fire regime is a nonlethal type with a fire return interval of 5 to 25 years.	Endemic insect and disease populations. Tree mortality not over 10% of host type and mortality groups have less than 50 trees. <40% of trees have dwarf mistletoe; <10% with stem rust and root disease centers. Fire regime is a nonlethal type with a fire return interval of 5 to 25 years.	Endemic insect and disease populations. Pockets of mortality do not exceed 5 trees per acre. Mortality groups of <10 trees. <1% of trees with black stain, <10% with root disease, <20% with dwarf mistletoe or stem rust. Fire regime is a nonlethal type with a fire return interval of 5 to 25 years.
PATTERNS (e.g. connectivity, shapes, size, distribution)	Patterns are within historical ranges. The role of fire is to maintain open stands of ponderosa pine.	Patterns are within historical ranges. (corridors are present and functional.) Role of fire is to maintain open stands of ponderosa pine.	Patterns are within historical ranges. (Pattern sizes, shapes and corridors are maintaining processes.) Periodic fires create uneven-aged stands composed of various even-aged groups.

SUBJECT: PINYON - JUNIPER (<i>Pinus edulis</i> or <i>P. monophylla</i> with <i>Juniperus osteosperma</i>)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages.	40% is Mature and Old.	Balanced Range: Grass/forb <input type="checkbox"/> 10% Seedling/Sapling <input type="checkbox"/> 10% Young Forest <input type="checkbox"/> 20% Mid Aged Forest <input type="checkbox"/> 20% Mature Forest <input type="checkbox"/> 20% Old Forest <input type="checkbox"/> 20%
<u>COMPOSITION</u>	Pinyon - Juniper are dominant.	Forbs, grasses and shrubs are resilient.	Shrub, forb and grass composition make up 20% or more of total vegetation. Bare ground less than 30%. Rock cover is common.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insect and disease populations cause less than 10% mortality in host type. <40% have dwarf or true mistletoe. < 5% have black stain fungus. Fire regimes are within historical ranges. The fire return interval is 10 to 30 years.	Endemic insect and disease populations cause less than 10% mortality in host type. <30% have dwarf or true mistletoe. < 5% have black stain fungus. Fire regimes are within historical ranges. The fire return interval is 10 to 30 years.	Endemic insect and disease populations. Fires burning every 10 to 30 years prevent pinyon-juniper stands from spreading into neighboring grasslands/shrublands.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns are within historical ranges. Fire maintains open (sparse) stands of pinyon-juniper and limits the spread of pinyon-juniper into other vegetation types.	Patterns are within historical ranges. (corridors are present and functional.) Fire maintains open (sparse) stands of pinyon-juniper and limits the spread of pinyon-juniper into other vegetation types.	Patterns are within historical ranges. (Pattern sizes, shapes and corridors are maintaining processes.) Pinyon - Juniper is primarily limited to habitats which offer protection from fire such as bare ridgetops and rock outcrops.

SUBJECT: MOUNTAIN MAHOGANY (<i>Cercocarpus</i> spp.)	INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)		
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages, sizes and ages of individual shrubs. >35% annual leader growth is retained each year to assure flowering and seed set.	Balanced range of structural stages, sizes and ages of individual shrubs. >35% annual leader growth is retained each year to assure flowering and seed set.	Balanced Range: Grass/forb <input type="checkbox"/> 10-20% Early seral <input type="checkbox"/> 20-40% Mid seral <input type="checkbox"/> 20-40% Late seral <input type="checkbox"/> 20-40%
<u>COMPOSITION</u>	Herbaceous layers well developed. (i.e. 20% or more total cover.) Bare ground is less than 25% cover.	Herbaceous layers well developed. (i.e. 20% or more total cover.) Bare ground is less than 25% cover.	Herbaceous layers well developed. (i.e. 20% or more total cover.) Bare ground is less than 25%.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insects and disease affect less than 40% of the host type. 50-70 year fire cycles with a mixed severity/lethal fire regime.	Endemic insects and disease affect less than 30% of the host type. 50-70 year fire cycles with a mixed severity/lethal fire regime.	Endemic insects and disease and weather affect less than 20% of the host type. Insect defoliation <50% on individual plants for 3+ years. 50-70 year fire cycles with a mixed severity/lethal regime.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	20-40% of acres are in mid-seral or later structural stages in patches of >25 acres. Pattern is a more or less heterogenous mosaic of structural classes.	20-40% of acres are in mid-seral or later structural stages in patches of >25 acres. Pattern is a more or less heterogenous mosaic of structural classes.	20-40% of acres are in mid-seral or later structural stages in patches of >25 acres. Pattern is a more or less heterogenous mosaic of structural classes.

SUBJECT: GAMBLE OAK (<i>Quercus gambelii</i>)	INDICATORS OF A PROPERLY FUNCTIONING CONDITION		
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of size and age classes.	Balanced range of size and age classes.	Balanced Range: Grass/forb □ 10-20% Early seral □ 20-40% Mid seral □ 20-40% Late seral □ 20-40%
<u>COMPOSITION</u>	Herbaceous layers well developed. (i.e. 25% or more total herb cover.) < 10% composition of maple species.	Herbaceous layers well developed and distributed. Less than 10% of tree strata is made up of <i>Acer</i> , <i>Pinus</i> , <i>Pseudotsuga</i> , or <i>Abies</i> species.	Herbaceous layers well developed and distributed, bare ground is less than 25%. Less than 10% of tree strata is made up of <i>Acer</i> , <i>Pinus</i> , <i>Pseudotsuga</i> , or <i>Abies</i> species.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insects and disease affect less than 40% of the host type. Crown fires have a 20 to 50 year interval in this mixed severity fire regime.	Endemic insects and disease affect less than 30% of the host type. Crown fires have a 20 to 50 year interval in this mixed severity fire regime.	Weather, endemic insects and disease affect less than 20% of the host type. <20% branch and clump mortality caused by insects, disease or winter mortality. <50% insect defoliation for more than 3 years. Crown fires have a 20 to 50 year interval in this mixed severity fire regime.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	20-40% of acres are in mid-seral or later structural stages in patches of >25 acres. Pattern is a more or less heterogenous mosaic of structural classes. Fire helps to maintain these classes.	20-40% of acres are in mid-seral or later structural stages in patches of >25 acres. Pattern is a more or less heterogenous mosaic of structural classes. Fire helps to maintain these classes.	20-40% of acres are in mid-seral or later structural stages in patches of >25 acres. Pattern is a more or less heterogenous mosaic of structural classes. Fire helps to maintain these classes.

SUBJECT: <u>TALL FORB</u>		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Dominated by tall forb species.	Dominant tall forb component with 50% or more composition community by tall forb species.	Minimum ground cover of 85% leading into the winter season.
<u>COMPOSITION</u>	Minimum of 50% composition of tall forb indicator species on suitable habitat. (e.g. <i>Ligusticum</i> spp., <i>Osmorhiza</i> spp., <i>Geranium</i> spp.)	Mosaic dominance of tall forb indicator species.	Mosaic dominance of tall forb indicator species.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Herbivory in balance with restoration of tall forb habitat. Fire regime is within historical ranges.	Demonstrated stable or upward trend in tall forb indicator species. (See Lewis, 1990 and Mueggler, 1988.) Fire regime is within historical ranges.	Demonstrated stable or upward trend in tall forb indicator species. (See Lewis, 1990 and Mueggler, 1988.) Fire regime is within historical ranges.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns within historical range on areas still suitable for Tall forb dominance.	Patterns within historical range on areas still suitable for Tall forb dominance.	Patterns within historical range on areas still suitable for Tall forb dominance.

SUBJECT: MOUNTAIN BRUSH COMPLEX		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Multiple vegetation layers.	Multiple vegetation layers with alternating vertical dominance.	Multiple vegetation layers with alternating vertical dominance.
<u>COMPOSITION</u>	Balanced acreages of islands and stringers within other vegetation types.	Balanced shrub/herbaceous understory components.	Alternating prominence of shrub/herbaceous components with historical disturbance regimes, bare ground is less than 25%. Dominance of sprouting species.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Endemic insect, disease and fire regimes within historical ranges. Fire regime is mixed severity.	Insect, disease and fire intervals within 20-40 year cycles. Fire regime is mixed severity.	Insect, disease and fire intervals within 20-40 year cycles. Fire regime is mixed severity.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Interspersed island and stringers within historical ranges.	Acreages and dispersion within historical ranges.	Acreages and dispersion within historical ranges.

SUBJECT: BIG SAGEBRUSH/GRASSLAND (<i>Artemisa tridentata</i> complex)		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balanced range of structural stages.	Balanced range of structural stages. 40% of area with 15% or more crown cover (as measured by line intercept).	<p>Balanced Range:</p> <p>10% of area with 0-5% sagebrush crown cover.</p> <p>50% of area with 5-15% sagebrush crown cover.</p> <p>40% of area with >15% sagebrush crown cover.</p> <p>Bare ground less than 20% for Mtn. sagebrush with 15"+ precipitation, and less than 40% bare ground in valley sagebrush types with 7-15" of precipitation.</p>
<u>COMPOSITION</u>	Big sagebrush is dominant with an understory component of grasses and forbs.	Big sagebrush is dominant on all but 0-5% of the historical habitat.	Big sagebrush is dominant on all but 0-5% of the historical habitat.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Fire has a lethal fire regime on an approximately 20 year return cycle.	Fire has a lethal fire regime on an approximately 20 year return cycle. Drier sites may have a 20 to 40 year return interval.	Fire has a lethal fire regime on an approximately 20 year return cycle. Drier sites may have a 20 to 40 year return interval.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Patterns are within the historical range.	Patterns are within the historical range.	Patterns are within the historical range.

SUBJECT: AQUATIC AND TERRESTRIAL ANIMALS		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Age-classes/ reproductive cohorts of native fish, amphibians, and terrestrial wildlife present in adequate quantities and ratios to maintain viable populations.	Physical and biological habitat features (e.g. communities, seral stages, water bodies, etc.) are adequate to maintain viable animal populations, long-term.	Physical and biological habitat features (e.g. plant communities, seral stages; large woody debris; water body morphology) available within annual home range, adequate to maintain viable populations, long-term.
<u>COMPOSITION</u>	All native, adapted species are present, in stable to increasing populations, in suitable habitats. Exotic species, diseases and their vectors do not limit, displace or reduce the long-term viability of native species.	All native, species present, stable to increasing in suitable habitats. Exotic species and diseases do not limit, displace or reduce long-term viability of native species.	Extant native species present at sustainable population levels in habitats to which they are adapted.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Historical predators, prey, foods and habitats of native species are present, and support animal populations' viability, reproductive strategy and long-term sustainability.	Disturbances to animal habitats affect only small portions (<5%?) of animals' annual range or habitats.	Habitat features adequate to sustain viable populations are available within annual ranges of animals, even after disturbance. Population levels are sustainable within historical ranges.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Migration, distribution, reproduction, and genetic diversity of animal populations facilitated/unhindered by habitat distribution or connectivity. Populations stable in historical ranges.	Migration, distribution, reproduction, and genetic diversity of animal populations facilitated/unhindered by habitat distribution or connectivity. Populations stable in historical ranges.	Animal populations exhibit genetic and reproductive integrity, without habitat or sub-population isolation or fragmentation.

SUBJECT: <u>HYDROLOGIC REGIME</u>		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Water quantity and distribution within ranges defined for area.	Quantity and timing of flows within normal range. Little or no evidence of stream malfunction.	Stream base level stable. Head cuts and sediment are within historical ranges. Peak flows and base flows are within historical ranges of variability.
<u>COMPOSITION</u>	N/A	N/A	N/A
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Peak flows, mass movements, and flooding within historical range of variation. Percent of basin altered or disturbed within the historical range of variation.	Peak flows, mass movements, and flooding within historical range of variation. Percent of sub-basin altered or disturbed within the historical range of variation.	Peak flows, mass movements, and flooding within historical range of variation. Percent of watershed altered or disturbed within the historical range of variation.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	N/A	Channel maintains flows sufficient to maintain diverse water dependent landscape components.	Stream flow release sustain landscape components such as wet meadow, riparian areas, springs and seeps.

SUBJECT: <u>SOIL QUALITY</u>		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Amount of bare soil and soil loss within historical range of variation.	Amount of bare soil and soil loss within historical range of variation.	Absence of excessive erosion indicators such as rill/gully and pedestaling. Intensity and area extent of soil displacement and compaction are within acceptable ranges.
<u>COMPOSITION</u>	Large woody material and organic matter within historical range of variation.	Large woody material and organic matter within historical range of variation.	Large woody material and organic matter within historical range of variation. (e.g. in tons/acre by cover/habitat type required for soil sustainability.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Area or extent altered or disturbed within historical range of variation.	Area or extent altered or disturbed within historical range of variation.	Area or extent altered or disturbed within historical range of variation. Infiltration and percolation ranges sustain soil hydrologic function and minimize overland flow.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	N/A	N/A	N/A

SUBJECT: <u>RIPARIAN/WETLANDS</u>		INDICATORS OF A PROPERLY FUNCTIONING CONDITION (BY GEOGRAPHIC SCALE)	
CRITERIA	REGIONAL	SUBREGIONAL:	LANDSCAPE
<u>STRUCTURE</u>	Balance between the vegetation, soil and water resources.	Balance between the vegetation, soil and water resources.	Amount and type of vegetation community types present that maintain riparian dependent resources and provide a high rate of recovery following disturbance.
<u>COMPOSITION</u>	Extent and distribution of riparian and wetland areas reflective of historical ranges.	Amounts and kinds of vegetation and physical properties sustain riparian dependent resources.	The plant community type composition emphasizes hydrophytic vegetation. Stream gradients, meanders, sediment amounts and general flow regimes are within historical range of variation.
<u>DISTURBANCE REGIME</u> (e.g. fire, insects, pathogens, flood, wind)	Within historical spatial and temporal disturbance patterns and recovery rates.	Rapid recovery of degraded or disturbed conditions. Frequently inundated flood plains reduce intensity of flooding.	Minimal carryover of disturbance features into the following years. Although dynamic, plant communities and hydrologic functions persist or recover rapidly.
<u>PATTERNS</u> (e.g. connectivity, shapes, size, distribution)	Sizes and distribution are within historical ranges.	Sizes and distribution are within historical ranges and maintain hydrologic functions.	Plant community type compositions and accompanying riparian ecosystem functions maintain proper ground water recharge, storage, delivery, water tables, channel morphology and bank stability.

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Fire Ecology, Fire and Fuels

Monroe Mountain Aspen Ecosystems Restoration Project

Appendix FL: Flame Length Analysis

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis

MAPS

Map FL - 1: Existing Condition. Flame lengths that could result from fire.

Map FL - 2: Alternative 1 – No Action. Flame lengths within 1 mile of private land that could result from fire.

Map FL - 3: Alternative 2. Flame lengths within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Map FL - 4: Alternative 3. Flame lengths within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Map FL - 5: Alternative 4. Flame lengths within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Map FL - 6: Alternative 5. Flame lengths within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Map FL - 7: Alternative 1 – No Action. Flame lengths that could result from fire.

Map FL - 8: Alternative 2. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Map FL - 9: Alternative 3. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Map FL - 10: Alternative 4. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Map FL - 11: Alternative 5. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Map FL - 12: Alternative 2 Cumulative Effects. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Map FL - 13: Alternative 3 Cumulative Effects. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Map FL - 14: Alternative 4 Cumulative Effects. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Map FL - 15: Alternative 5 Cumulative Effects. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

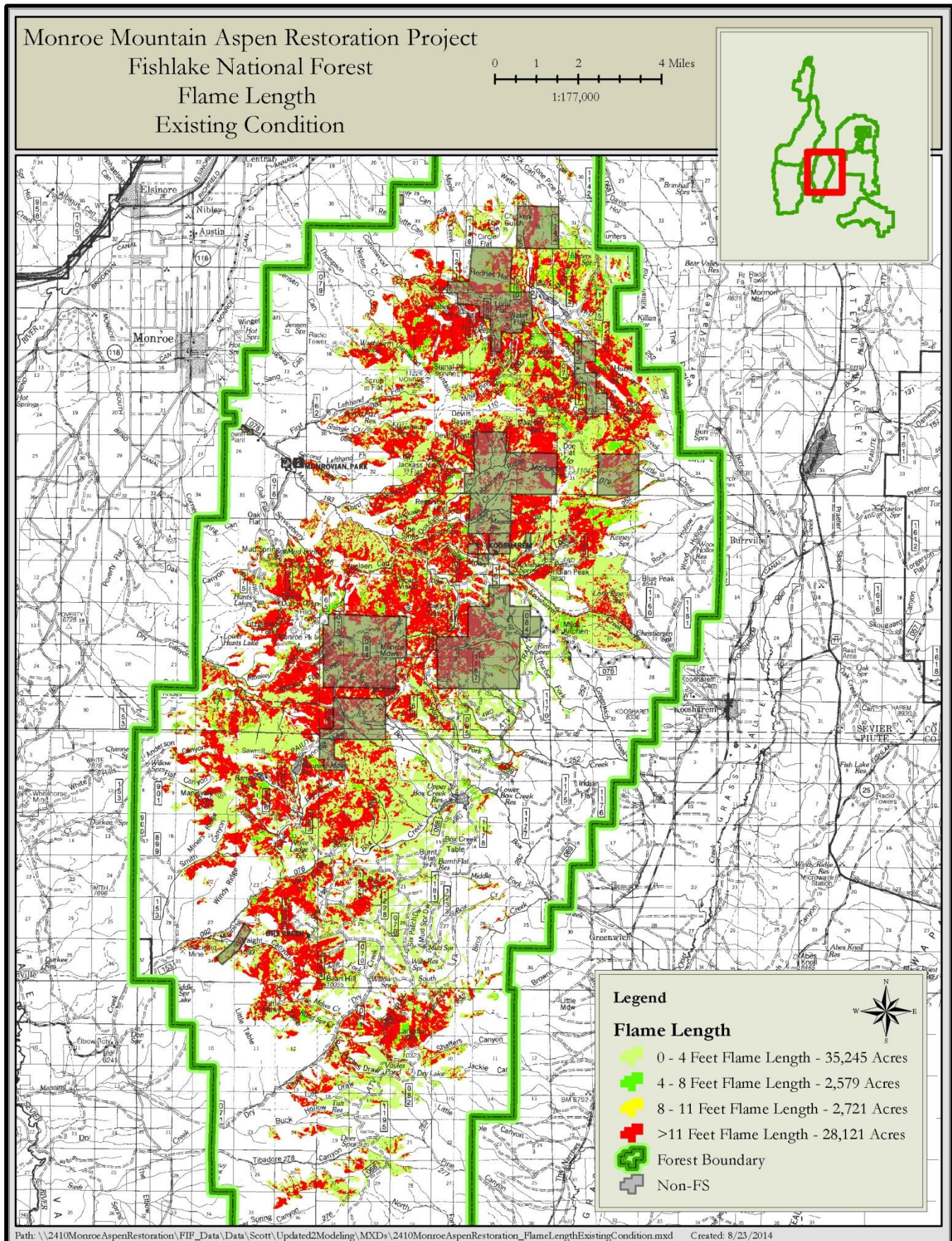
FIGURES

Figure FL - 1: Summary of Alternatives 1-5. Flame length within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Figure FL - 2: Summary of Alternatives 1-5. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

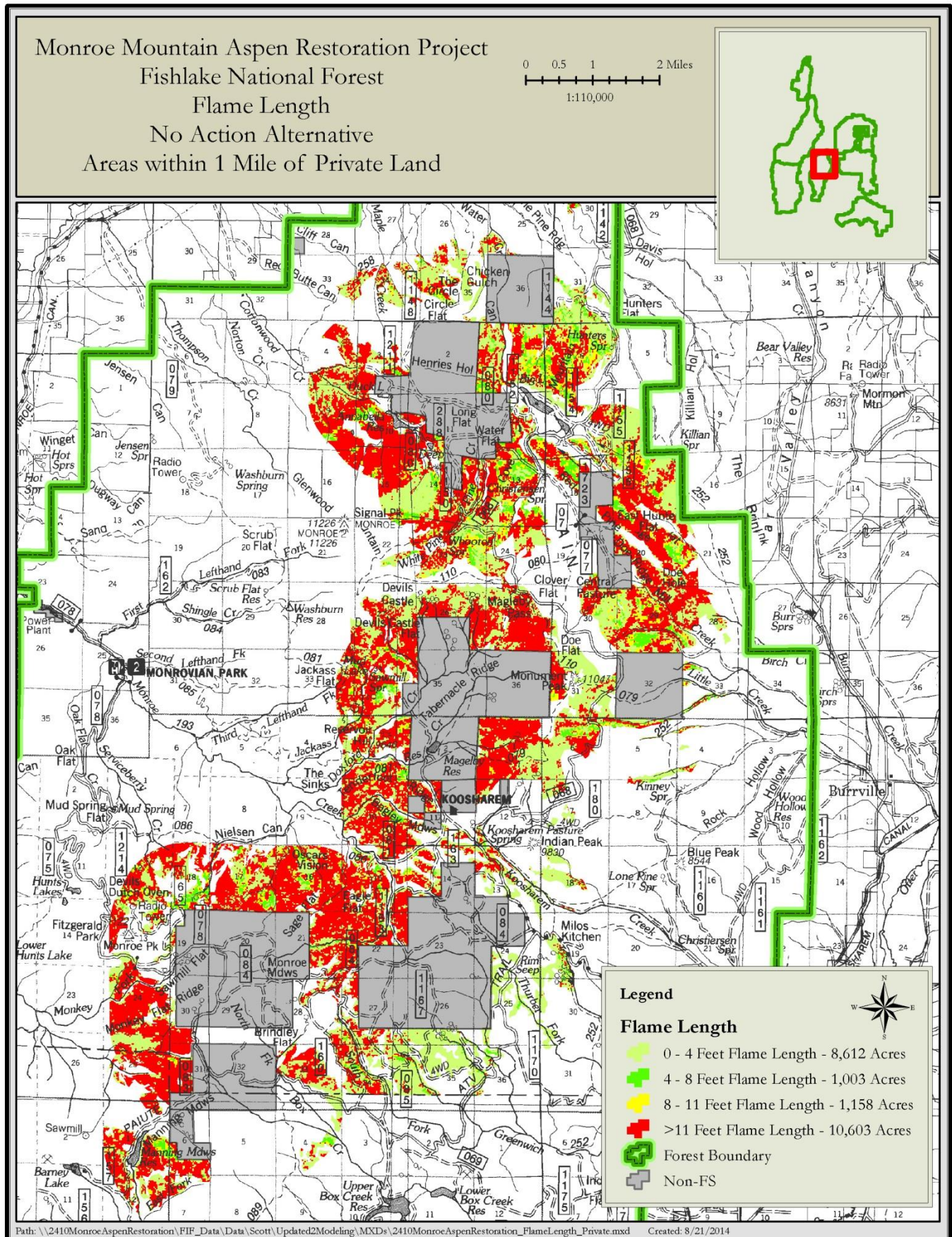
Figure FL - 3: Summary of Alternatives 1-5. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



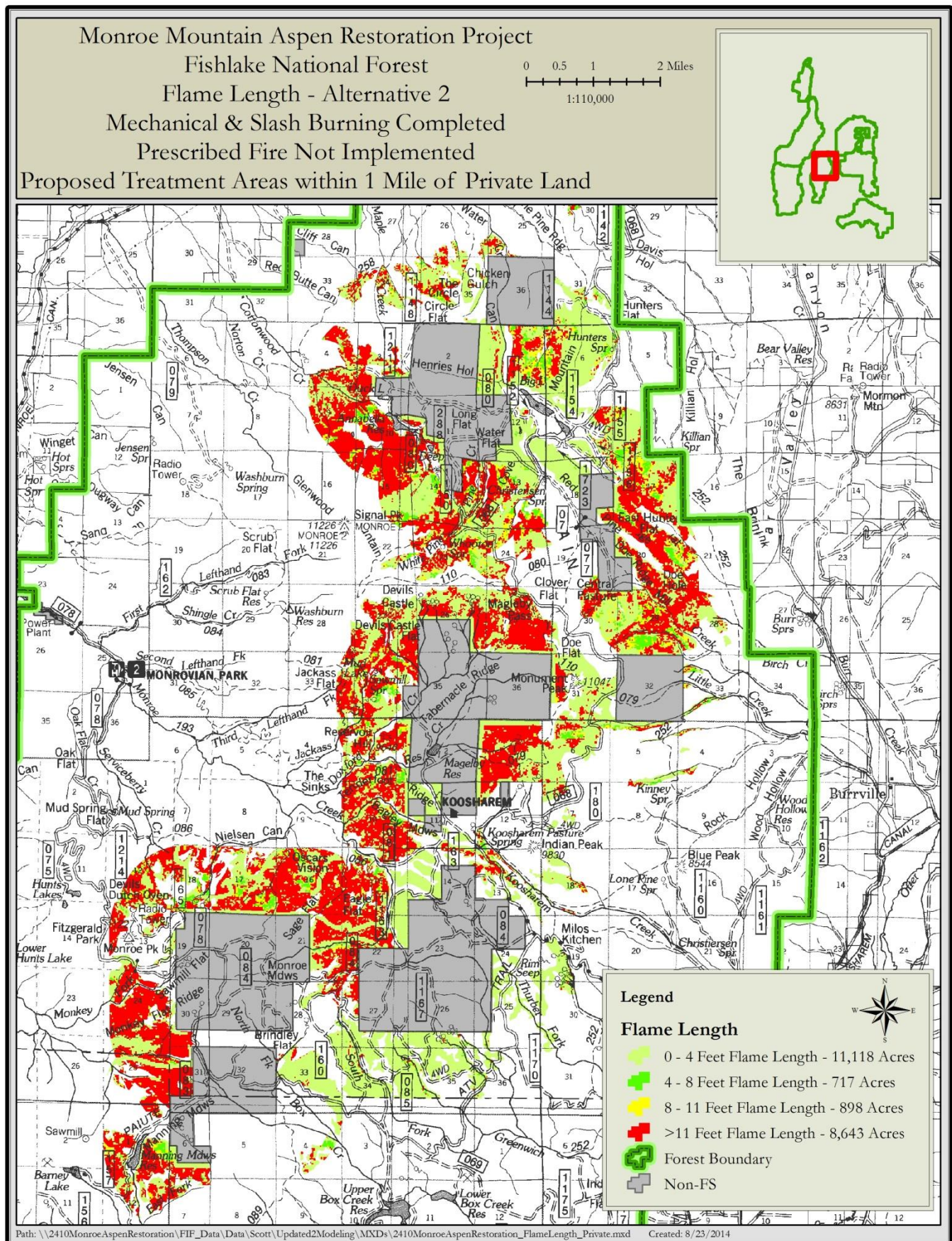
Map FL - 1: Existing Condition. Flame lengths that could result from fire.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



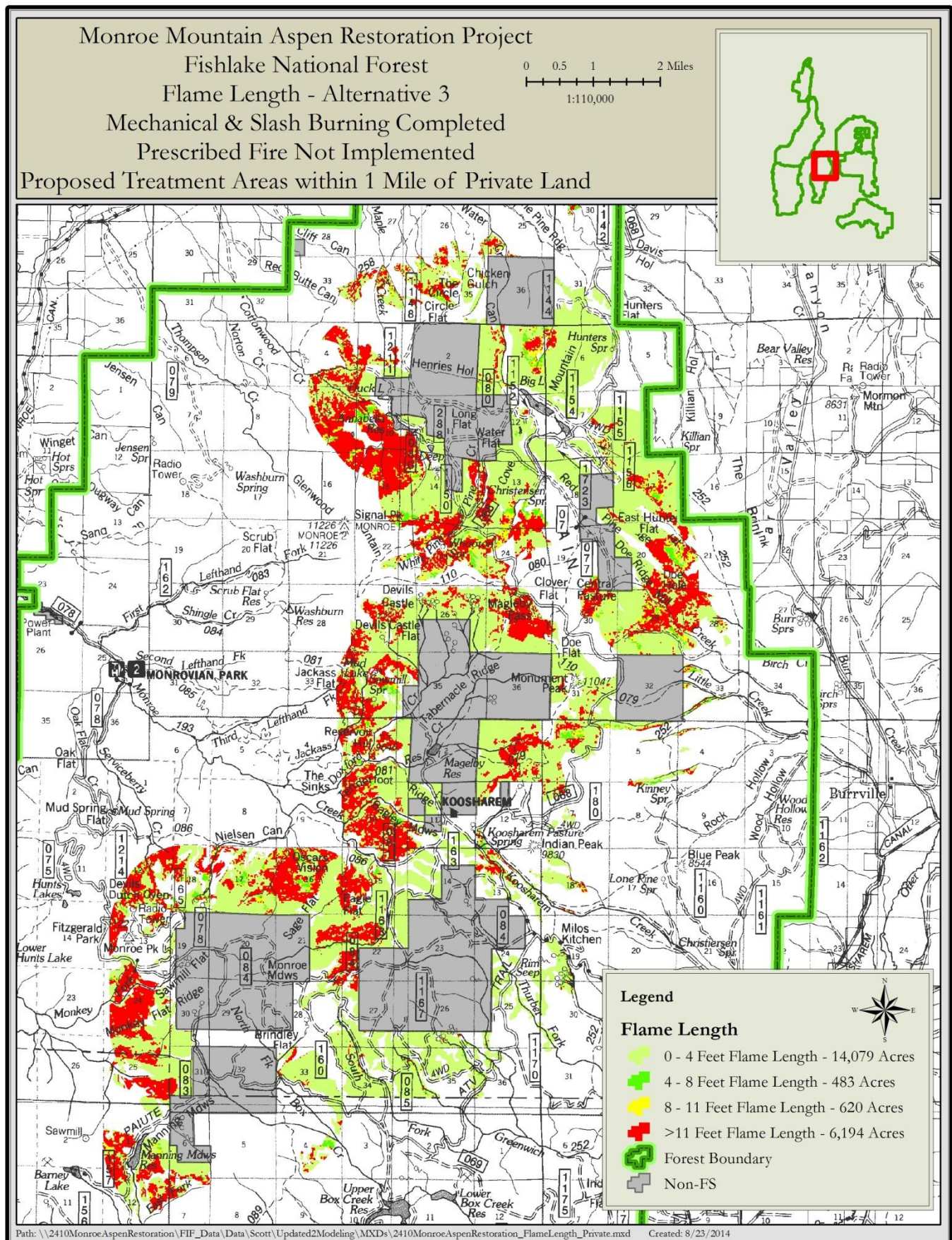
Map FL - 2: Alternative 1 – No Action. Flame lengths within 1 mile of private land that could result from fire.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



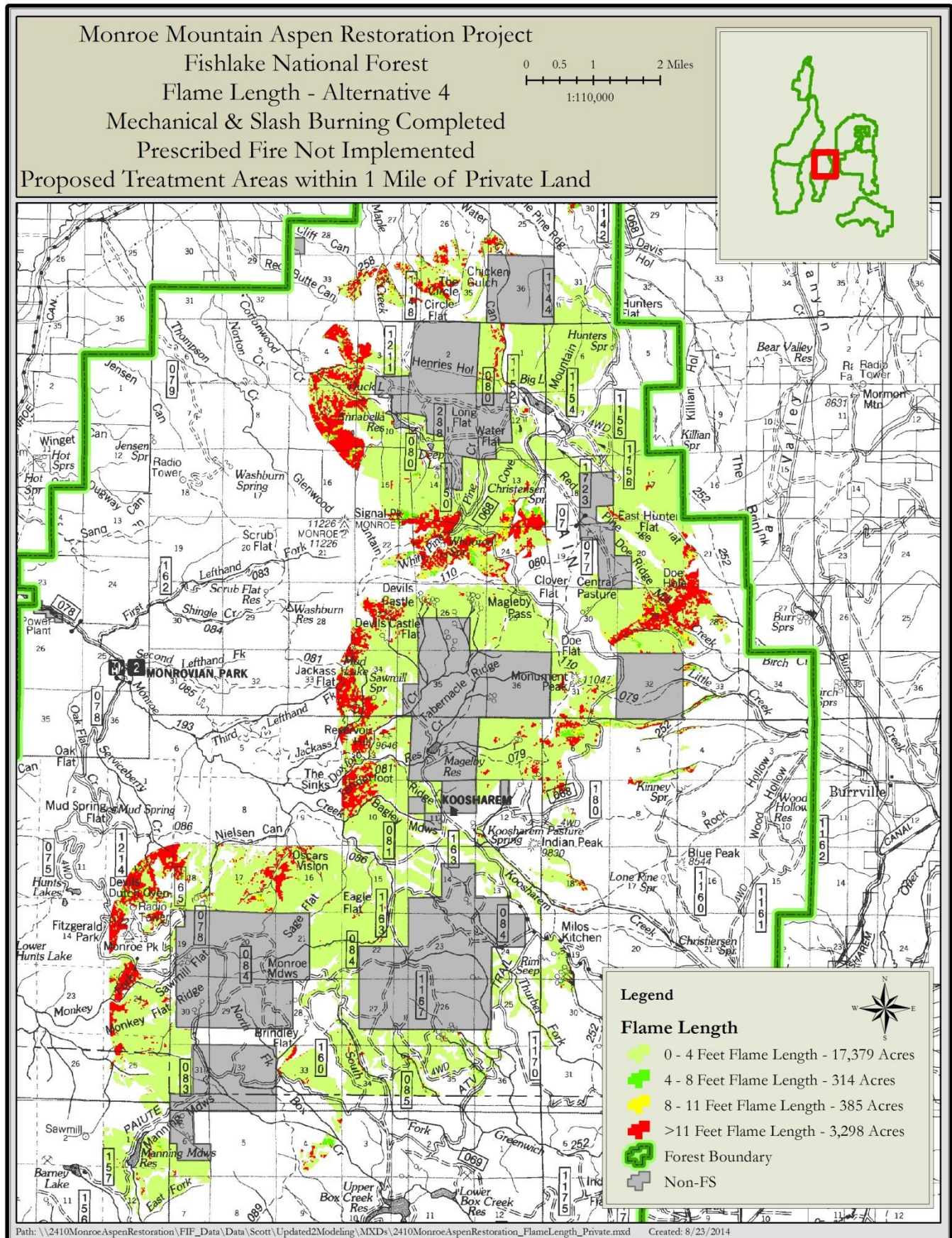
Map FL - 3: Alternative 2. Flame lengths within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



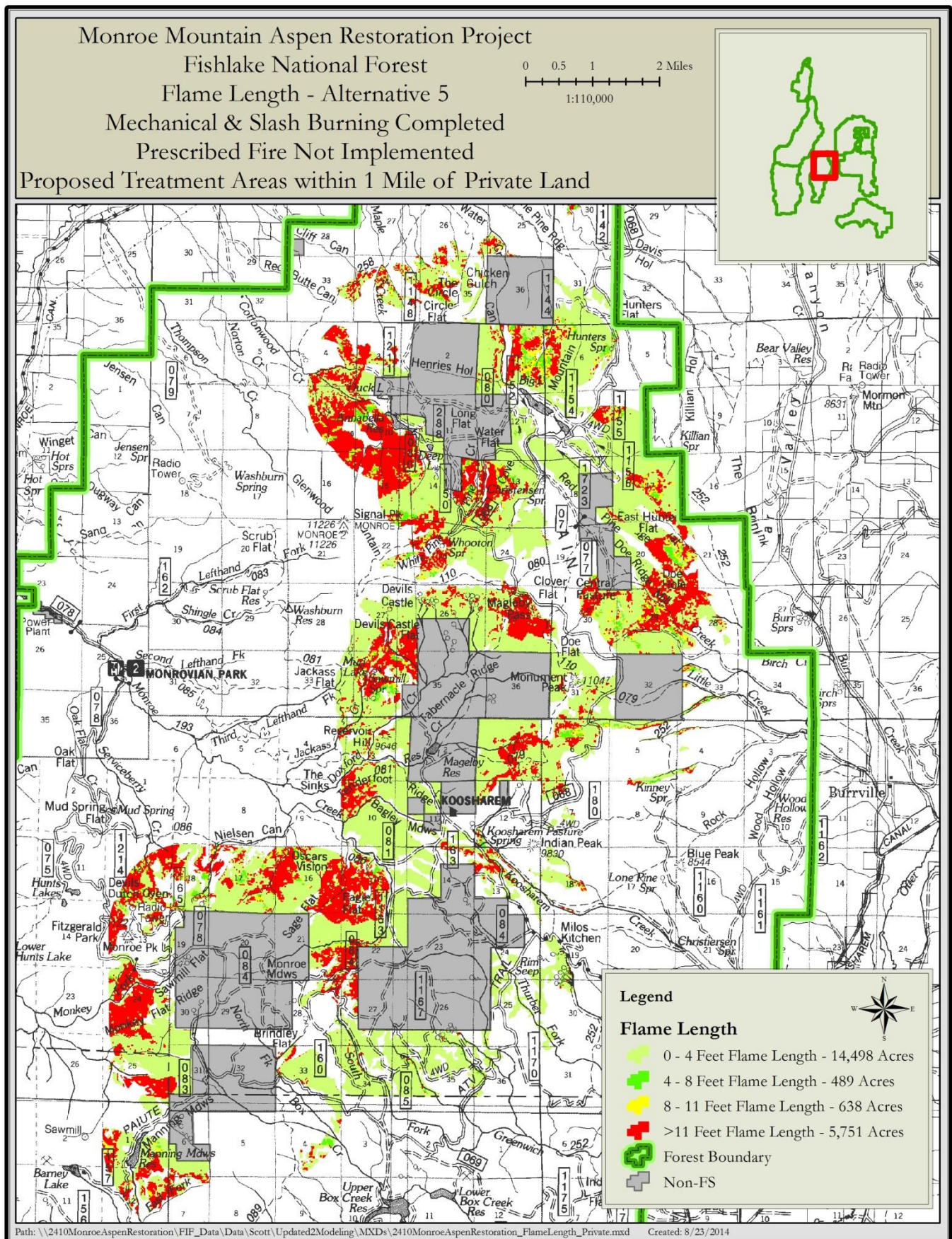
Map FL - 4: Alternative 3. Flame lengths within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



Map FL - 5: Alternative 4. Flame lengths within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



Map FL - 6: Alternative 5. Flame lengths within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis

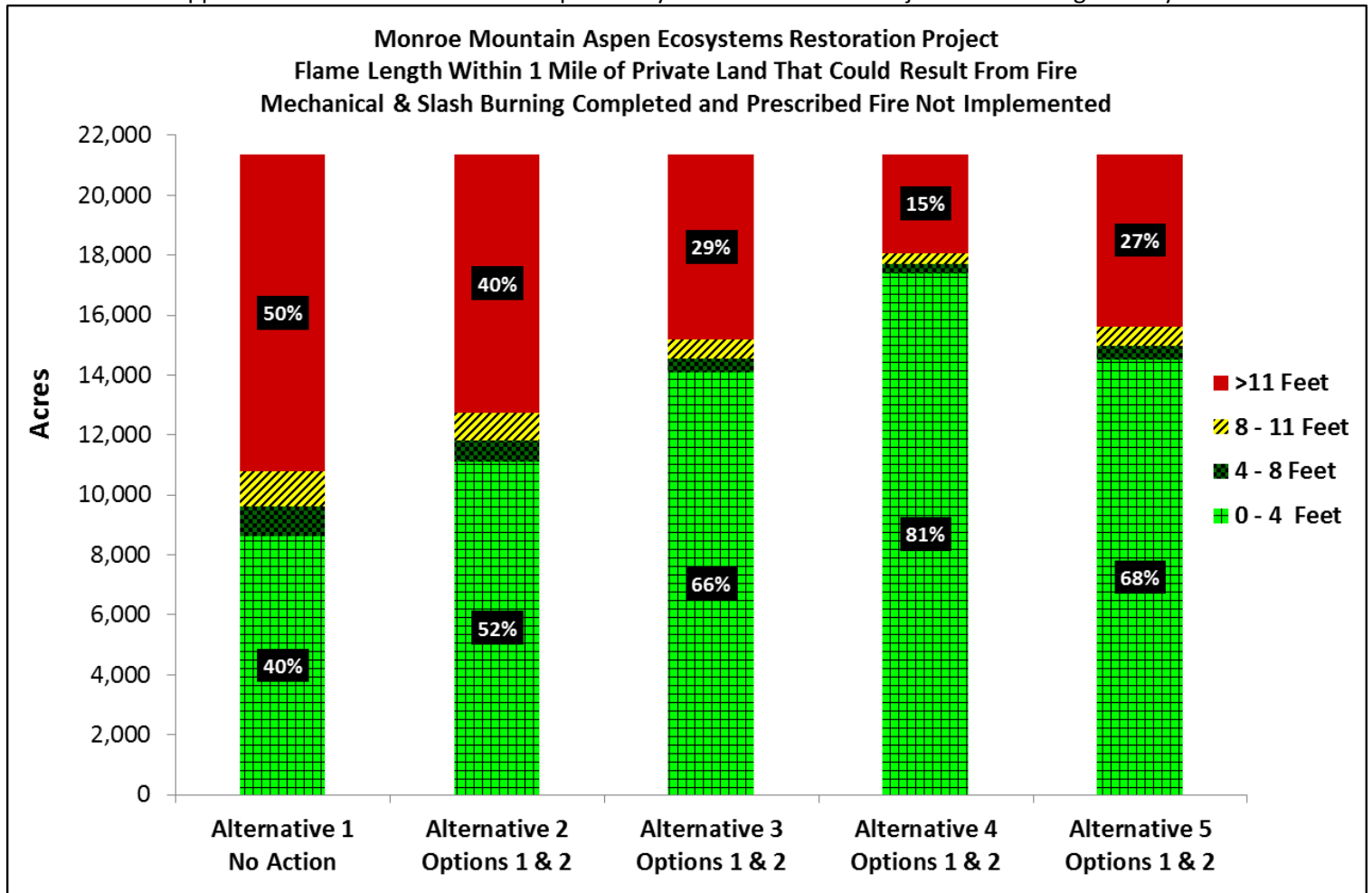
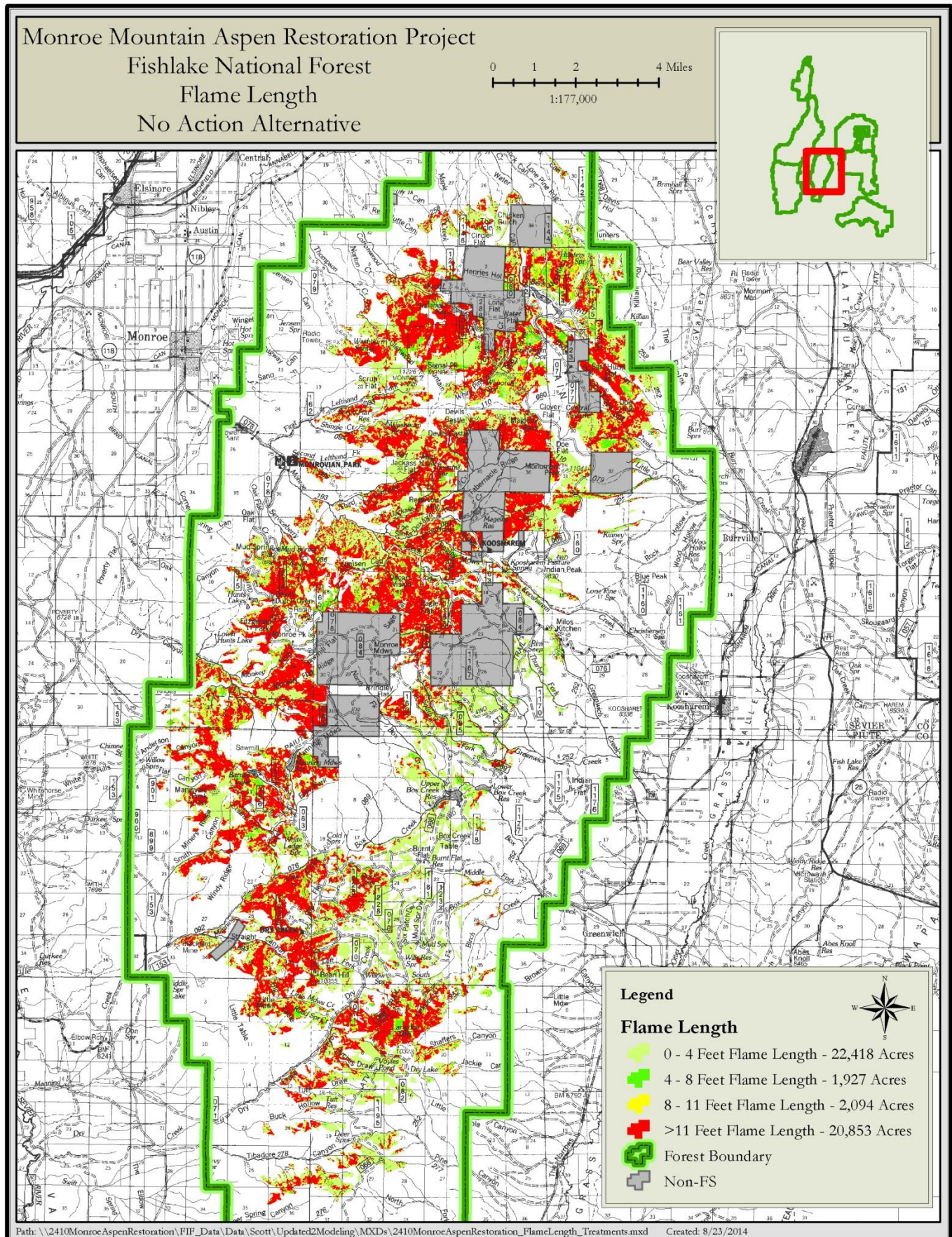


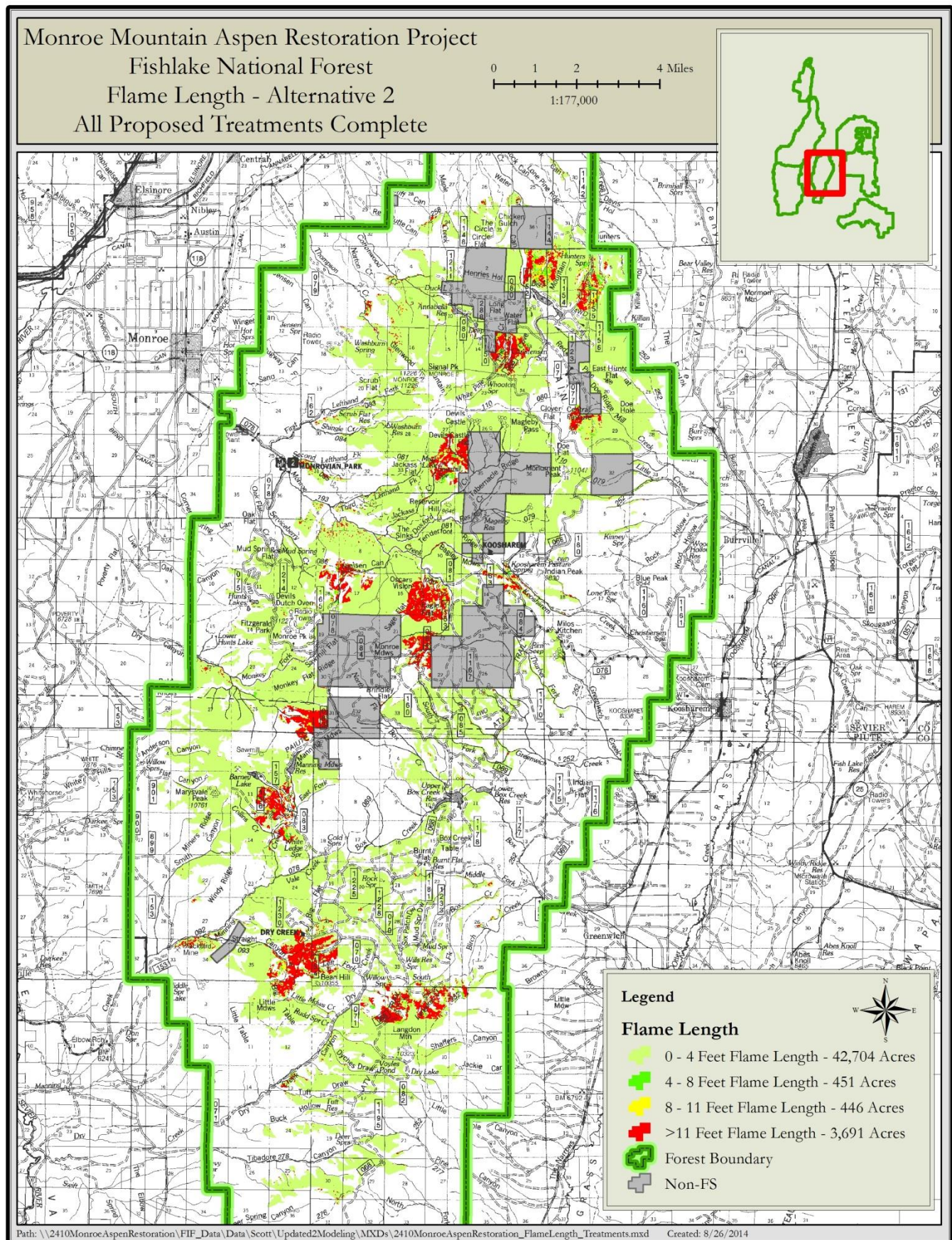
Figure FL - 1: Summary of Alternatives 1-5. Flame length within 1 mile of private land that could result from fire. Mechanical & slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



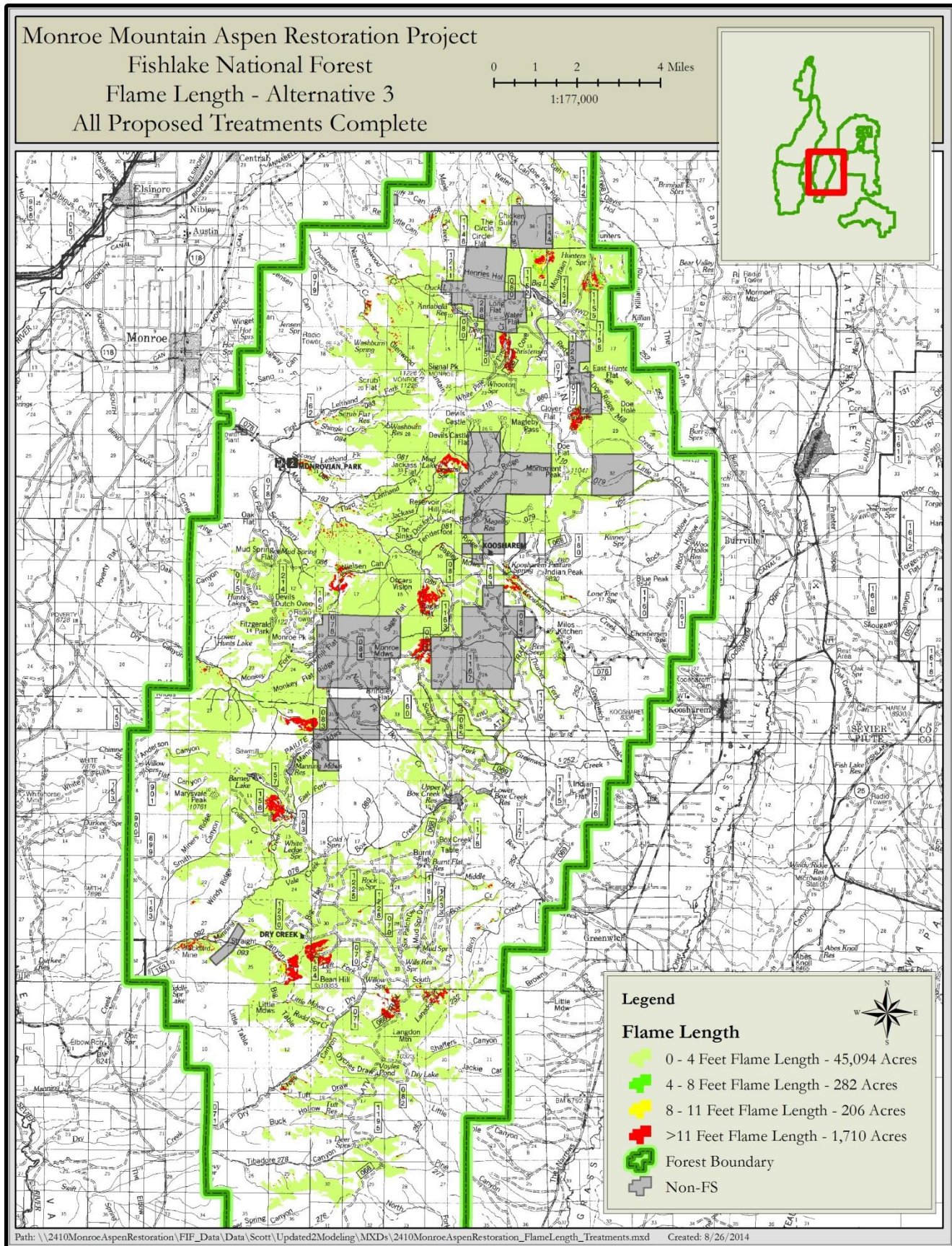
Map FL - 7: Alternative 1 – No Action. Flame lengths that could result from fire.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



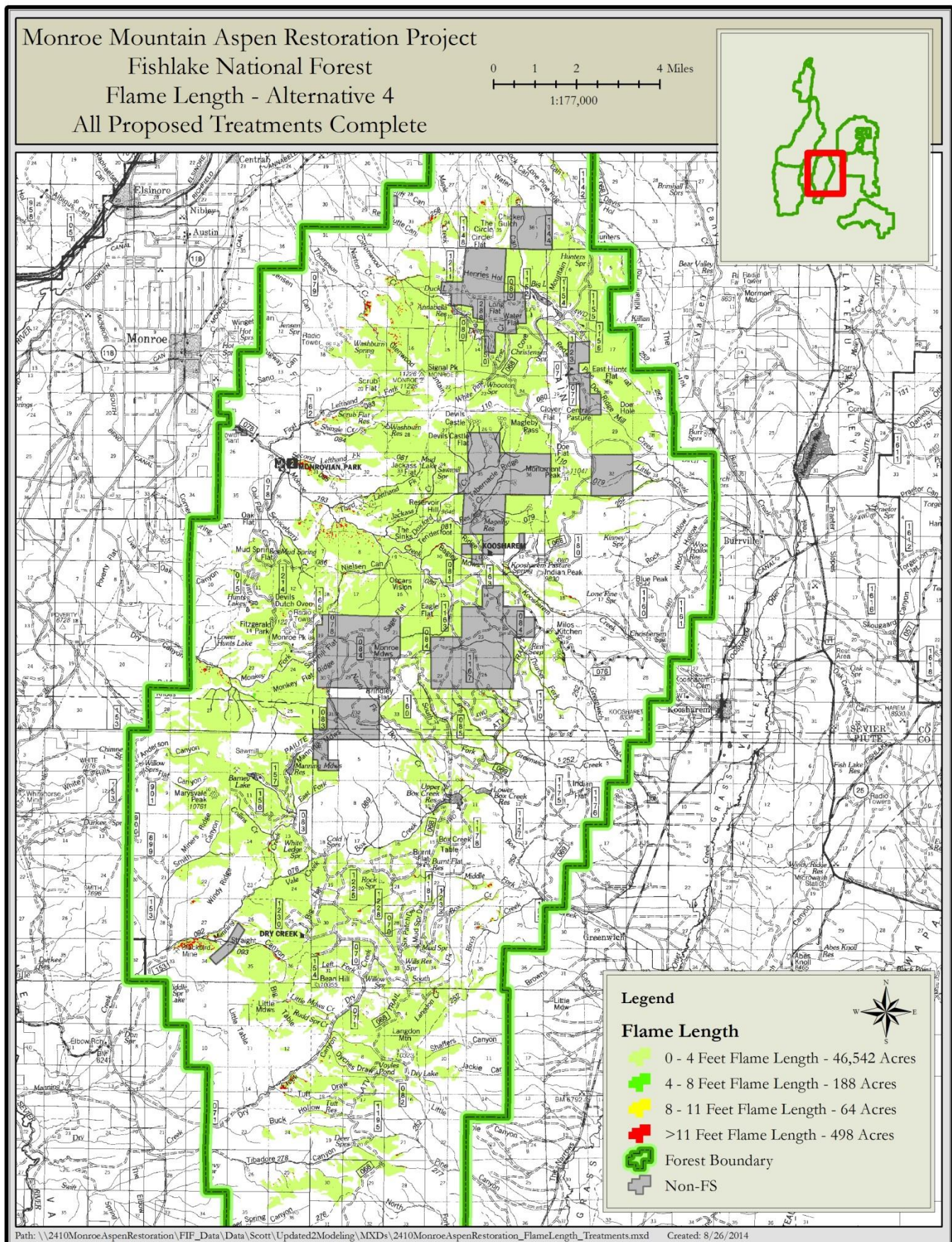
Map FL - 8: Alternative 2. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



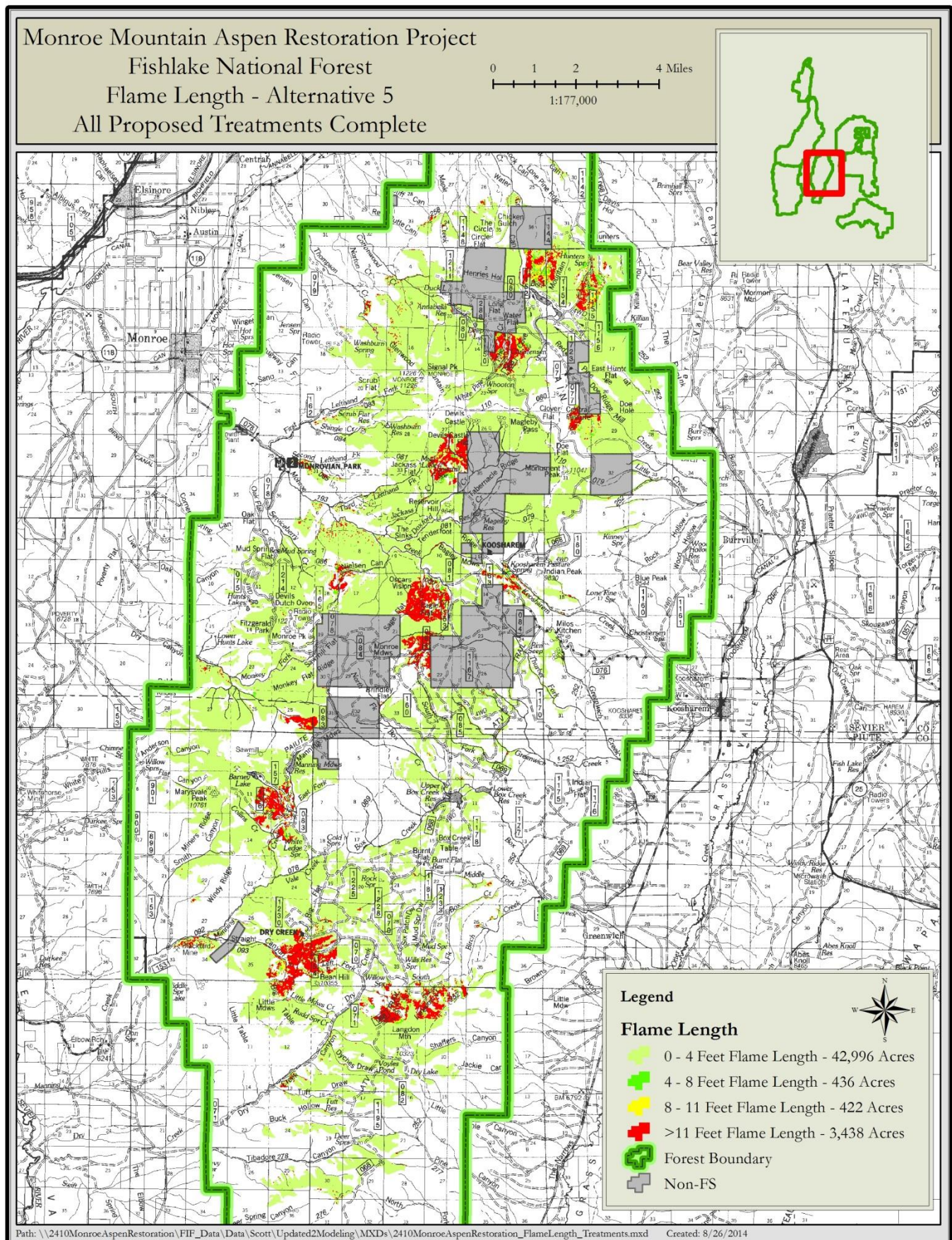
Map FL - 9: Alternative 3. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



Map FL - 10: Alternative 4. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



Map FL - 11: Alternative 5. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis

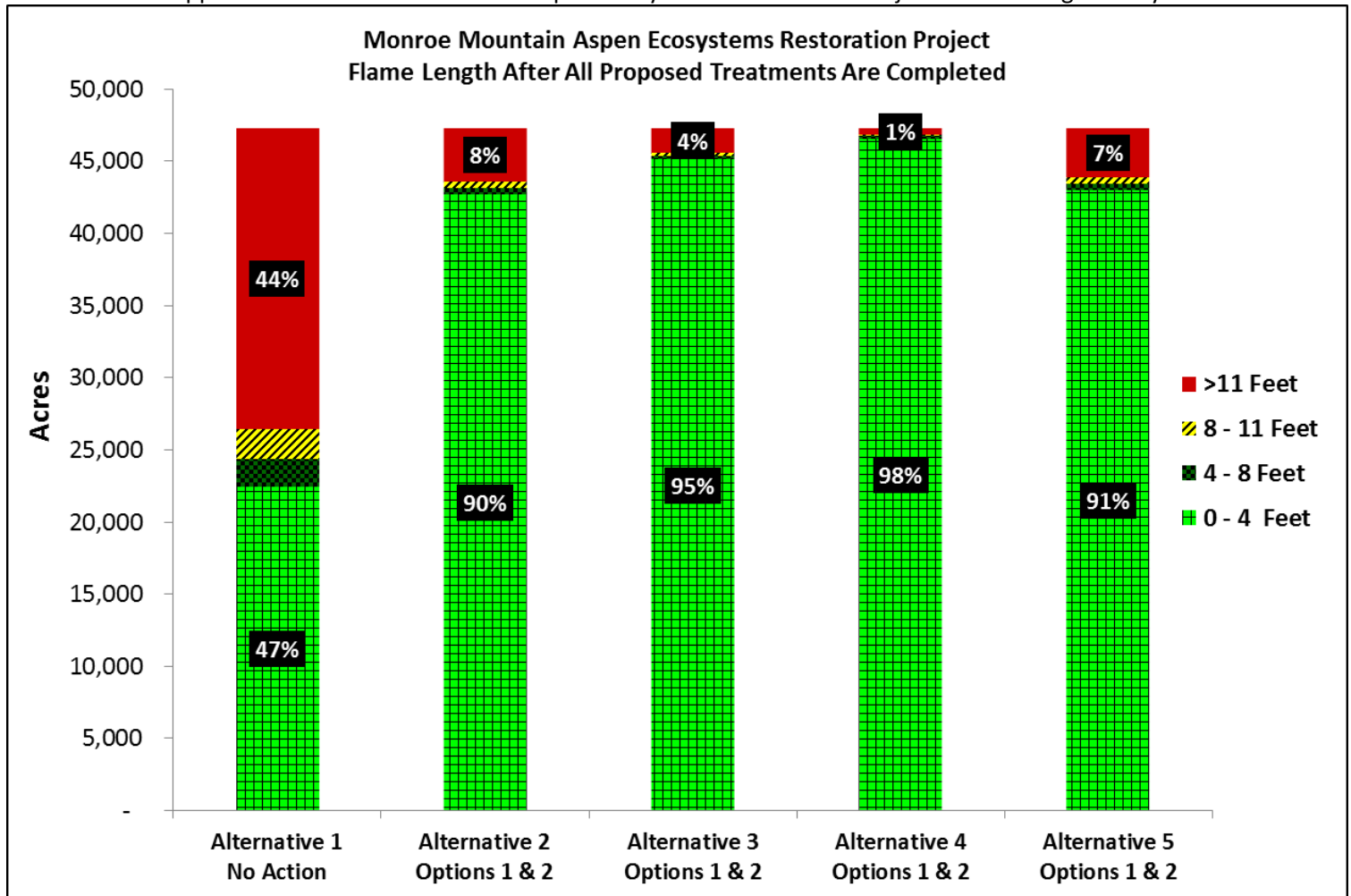
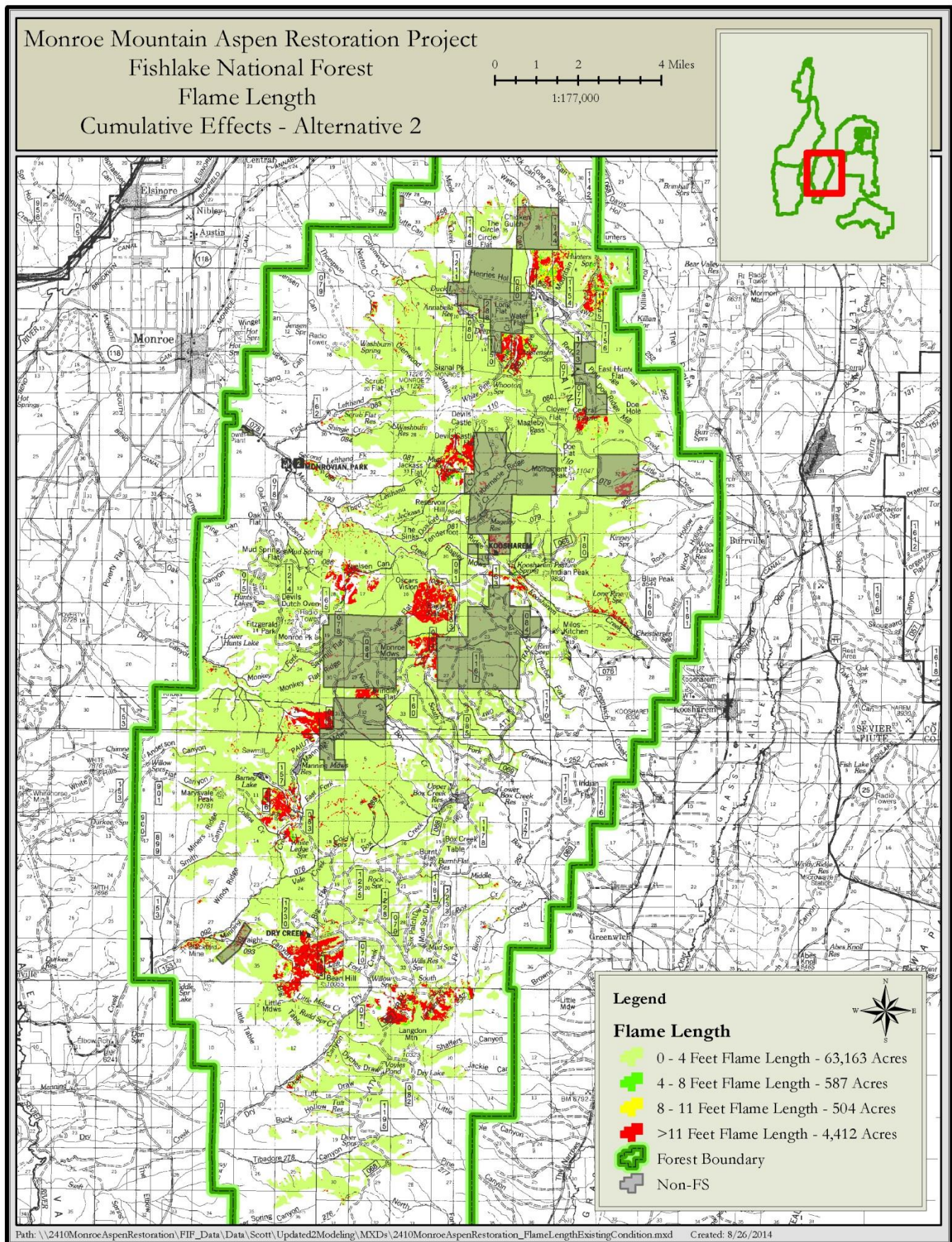


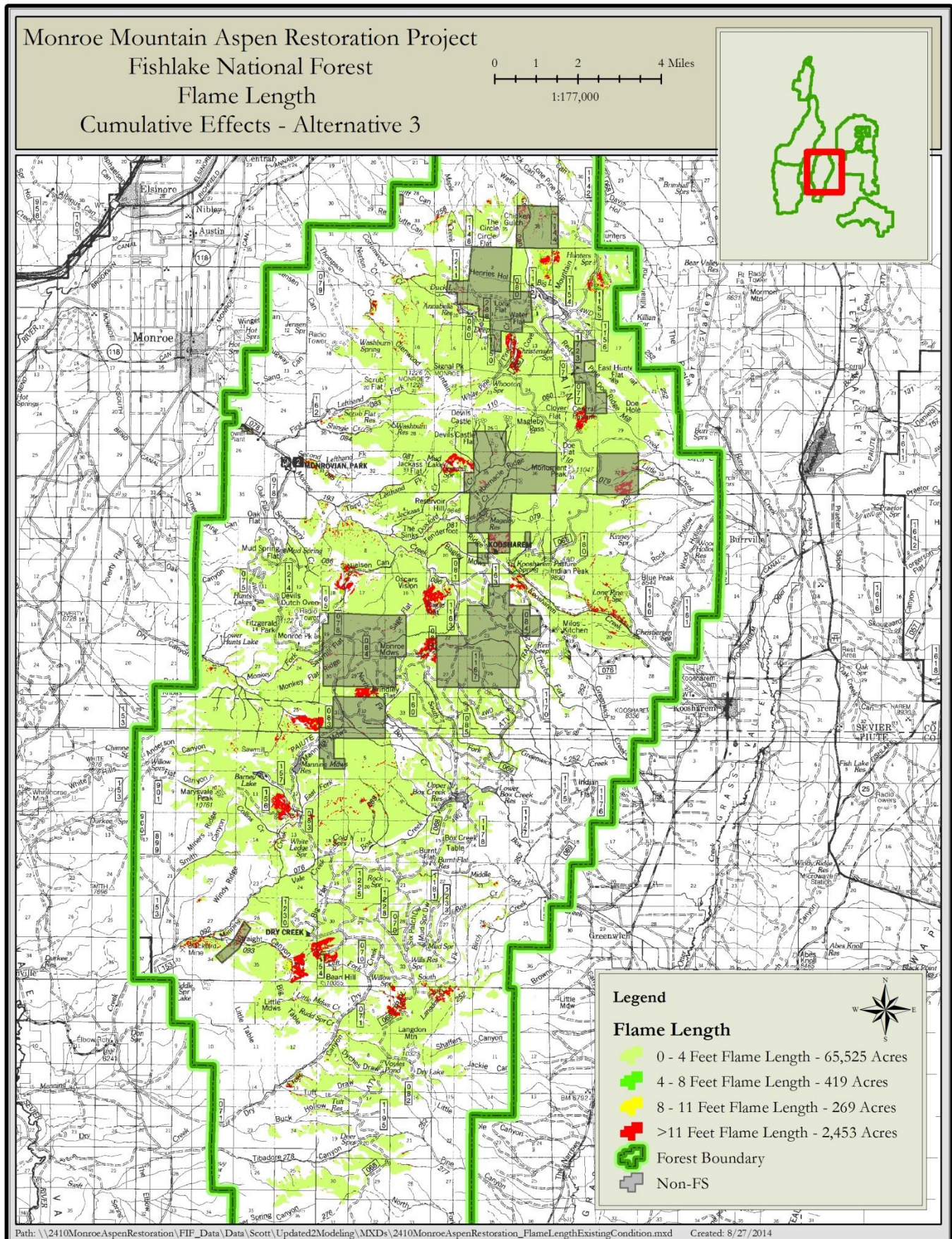
Figure FL - 2: Summary of Alternatives 1-5. Flame lengths that could result after all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



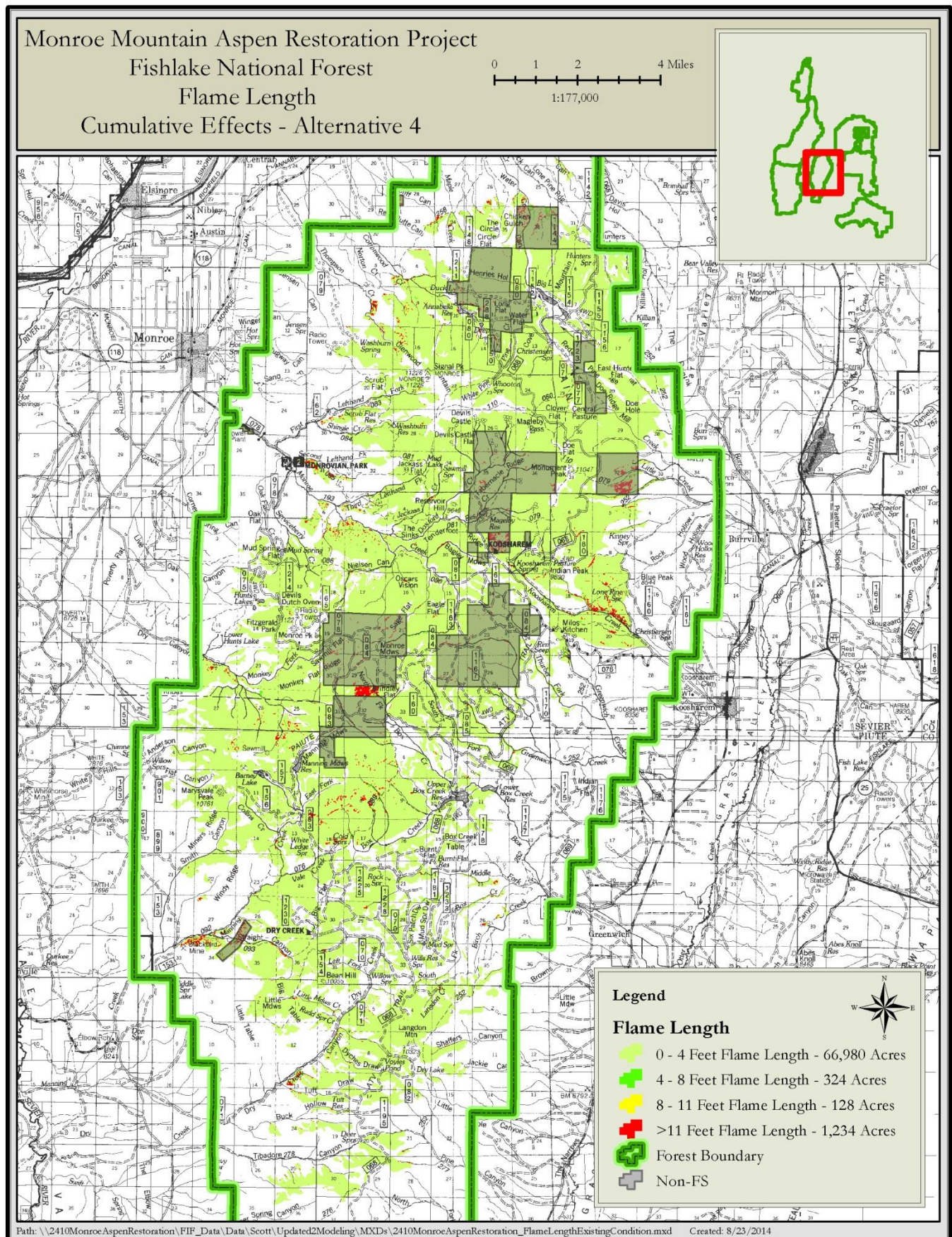
Map FL - 12: Alternative 2 Cumulative Effects. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



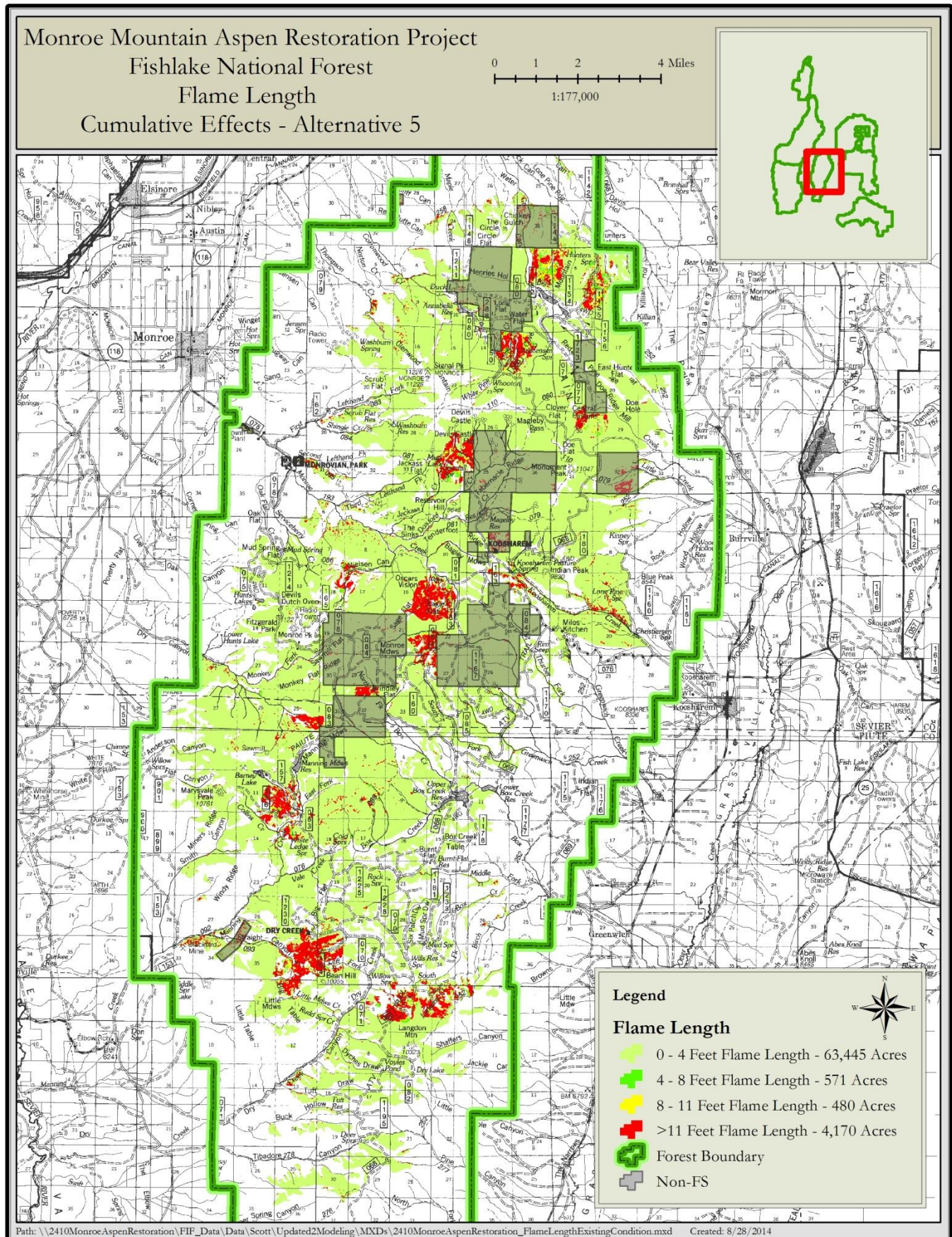
Map FL - 13: Alternative 3 Cumulative Effects. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



Map FL - 14: Alternative 4 Cumulative Effects. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis



Map FL - 15: Alternative 5 Cumulative Effects. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Appendix FL – Monroe Mountain Aspen Ecosystems Restoration Project. Flame Length Analysis

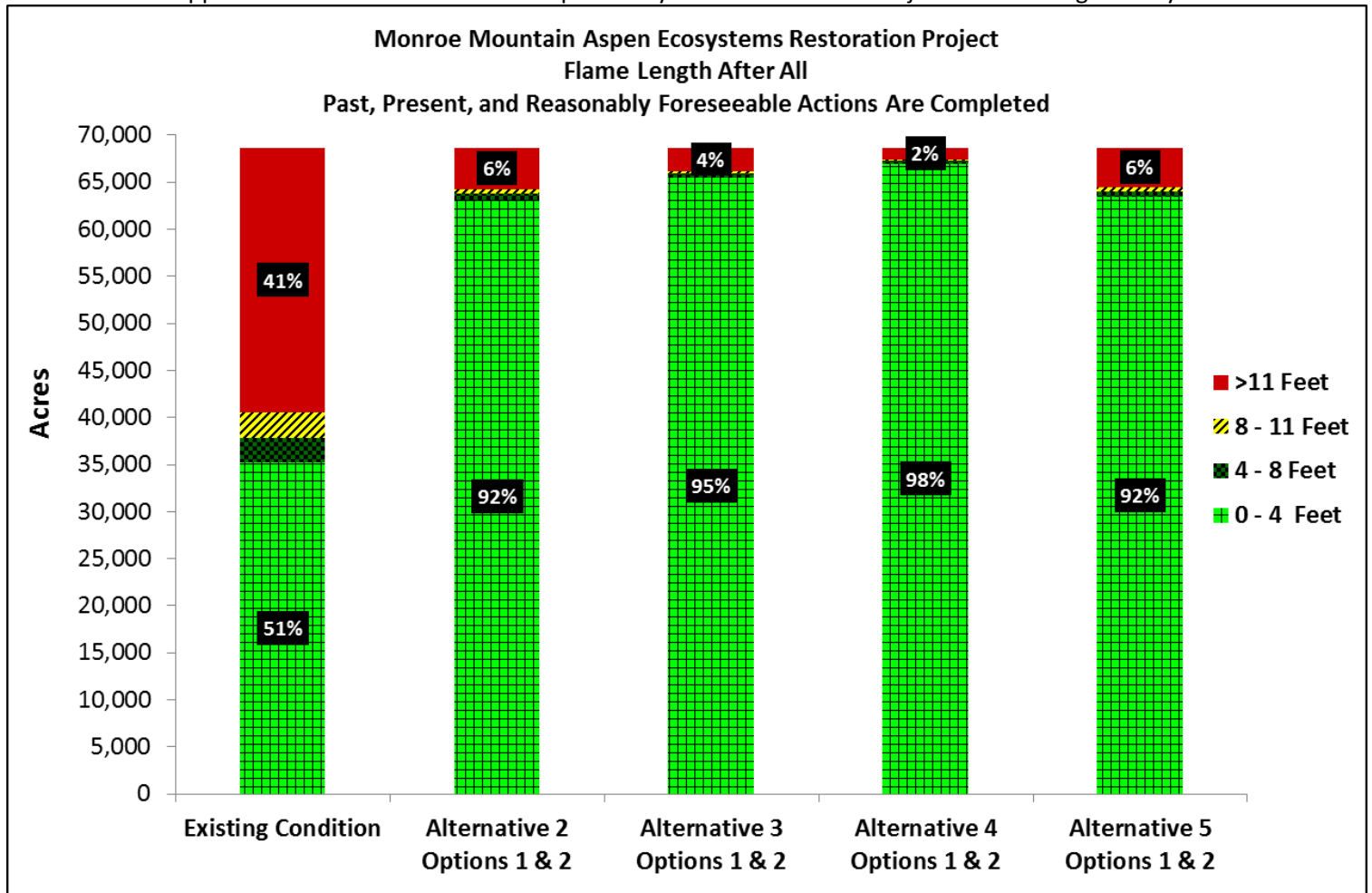


Figure FL - 3: Summary of Alternatives 1-5. Flame lengths that could result after all past, present, and reasonably foreseeable actions are completed.

Appendix S: Spotting Analysis

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.

MAPS

Map S - 1: Existing Condition. Acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 2: Alternative 1 – No Action. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 3: Alternative 2. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Map S - 4: Alternative 3. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Map S - 5: Alternative 4. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Map S - 6: Alternative 5. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Map S - 7: Alternative 1 – No Action. Acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 8: Alternative 2. After all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 9: Alternative 3. After all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 10: Alternative 4. After all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 11: Alternative 5. After all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 12: Alternative 2 Cumulative Effects. After all past, present, and reasonably foreseeable actions are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 13: Alternative 3 Cumulative Effects. After all past, present, and reasonably foreseeable actions are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 14: Alternative 4 Cumulative Effects. After all past, present, and reasonably foreseeable actions are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Map S - 15: Alternative 5 Cumulative Effects. After all past, present, and reasonably foreseeable actions are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.

FIGURES

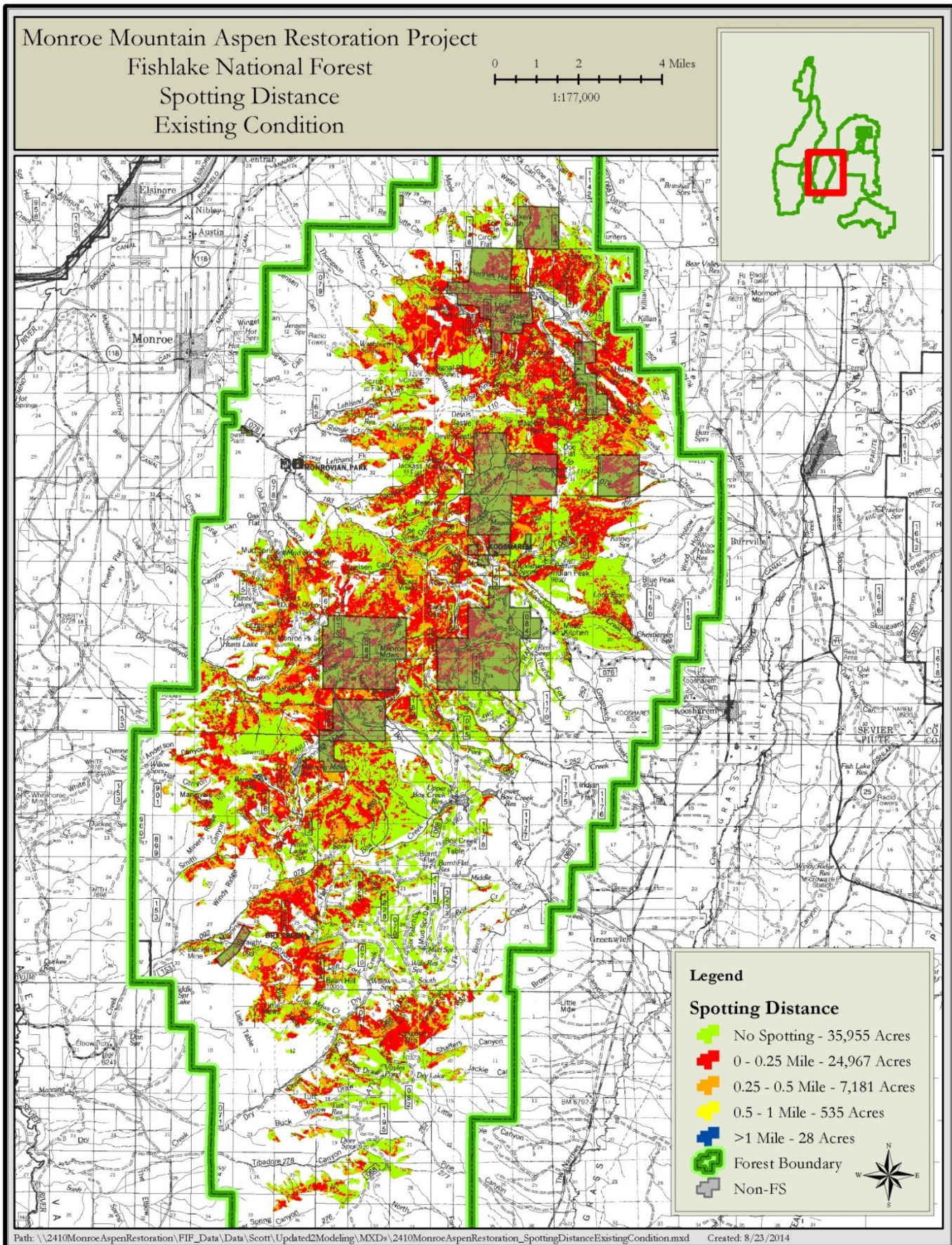
Figure S - 1: Summary of Alternatives 1-5. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning (Options 1 & 2) completed and prescribed fire not implemented.

Figure S - 2: Summary of Alternatives 1-5. Acres capable of producing embers that could develop spot fires on private land. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Figure S - 3: Summary of Alternatives 1-5. After all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

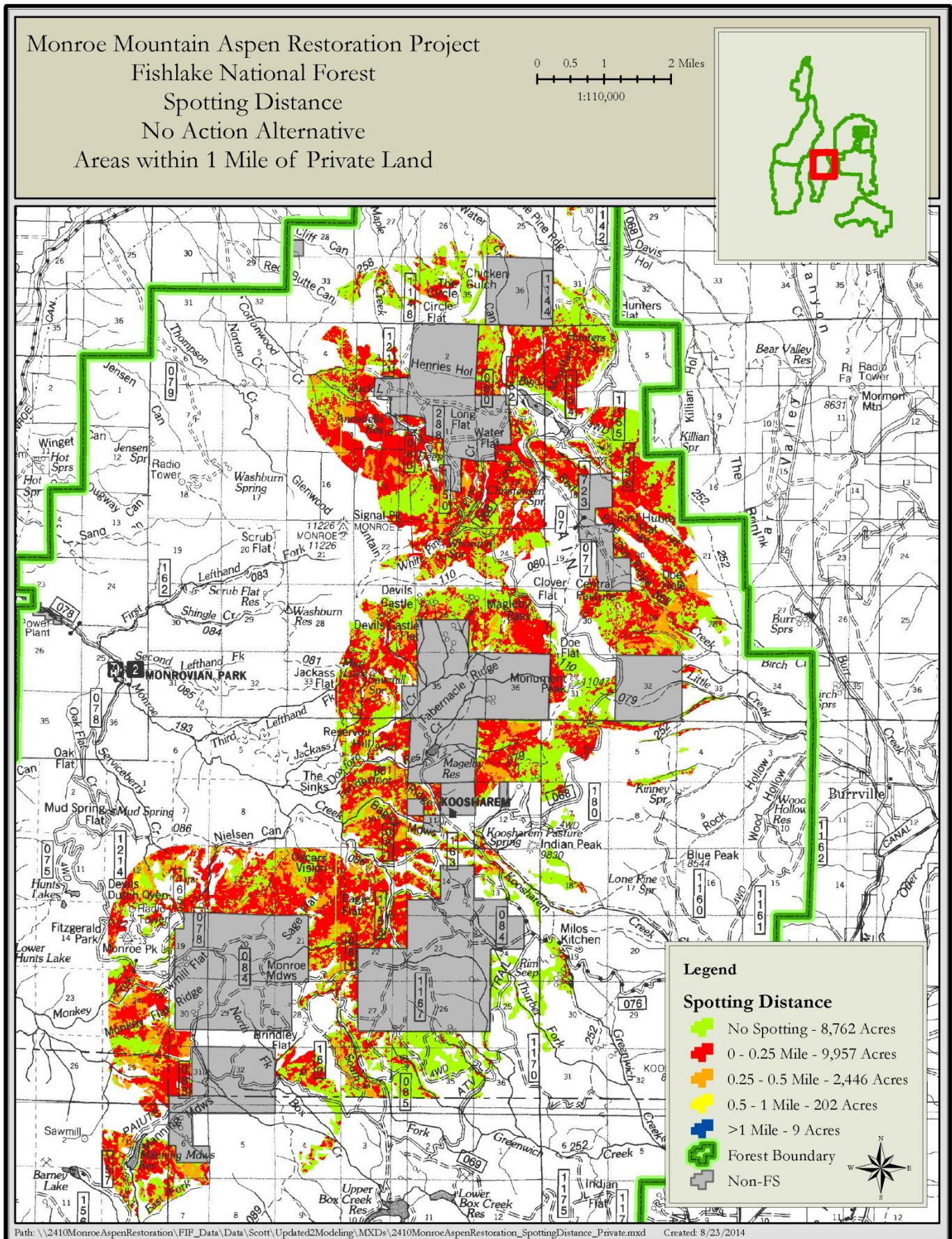
Figure S - 4: Summary of Alternatives 1-5. After all past, present, and reasonably foreseeable actions are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.



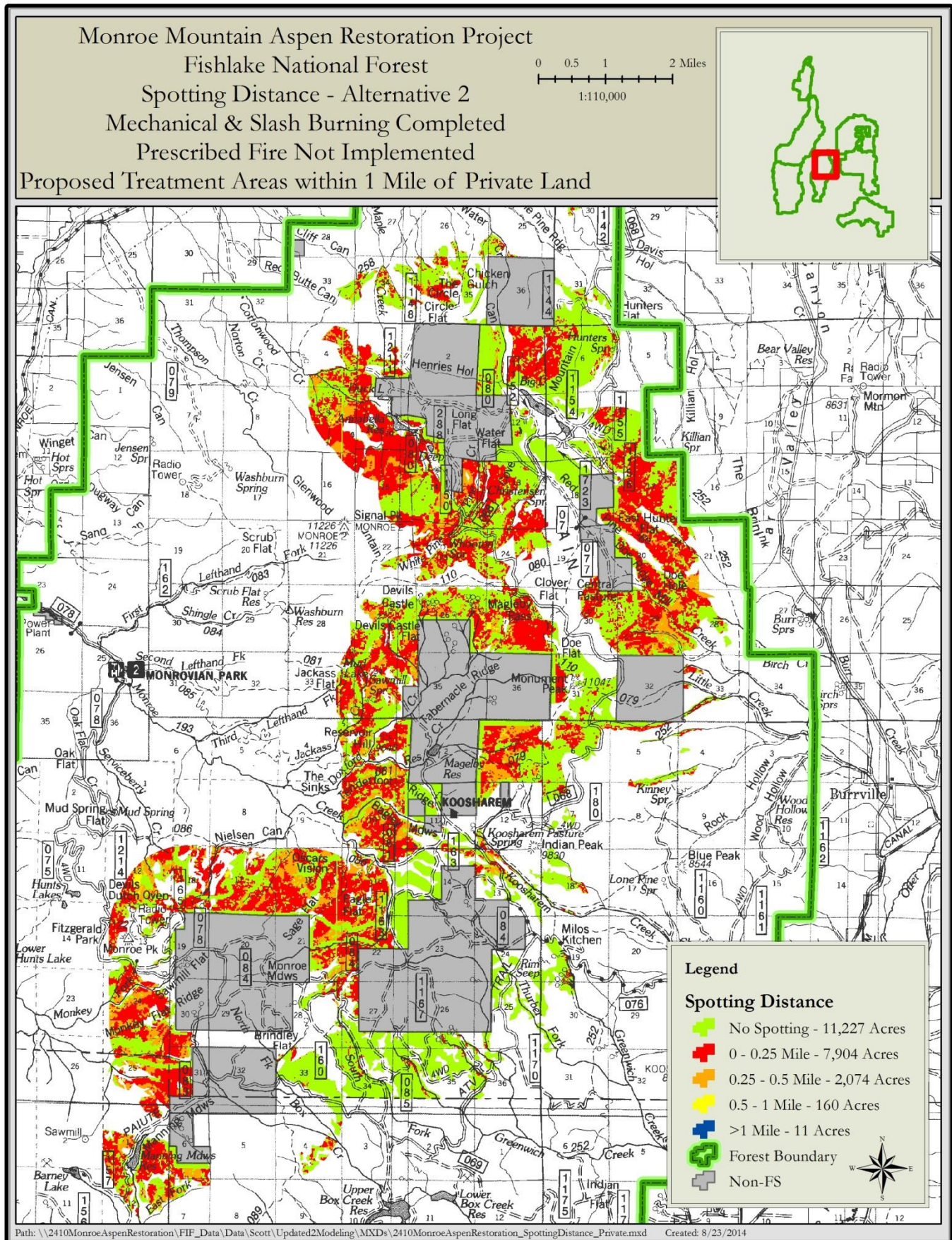
Map S - 1: Existing Condition. Acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.



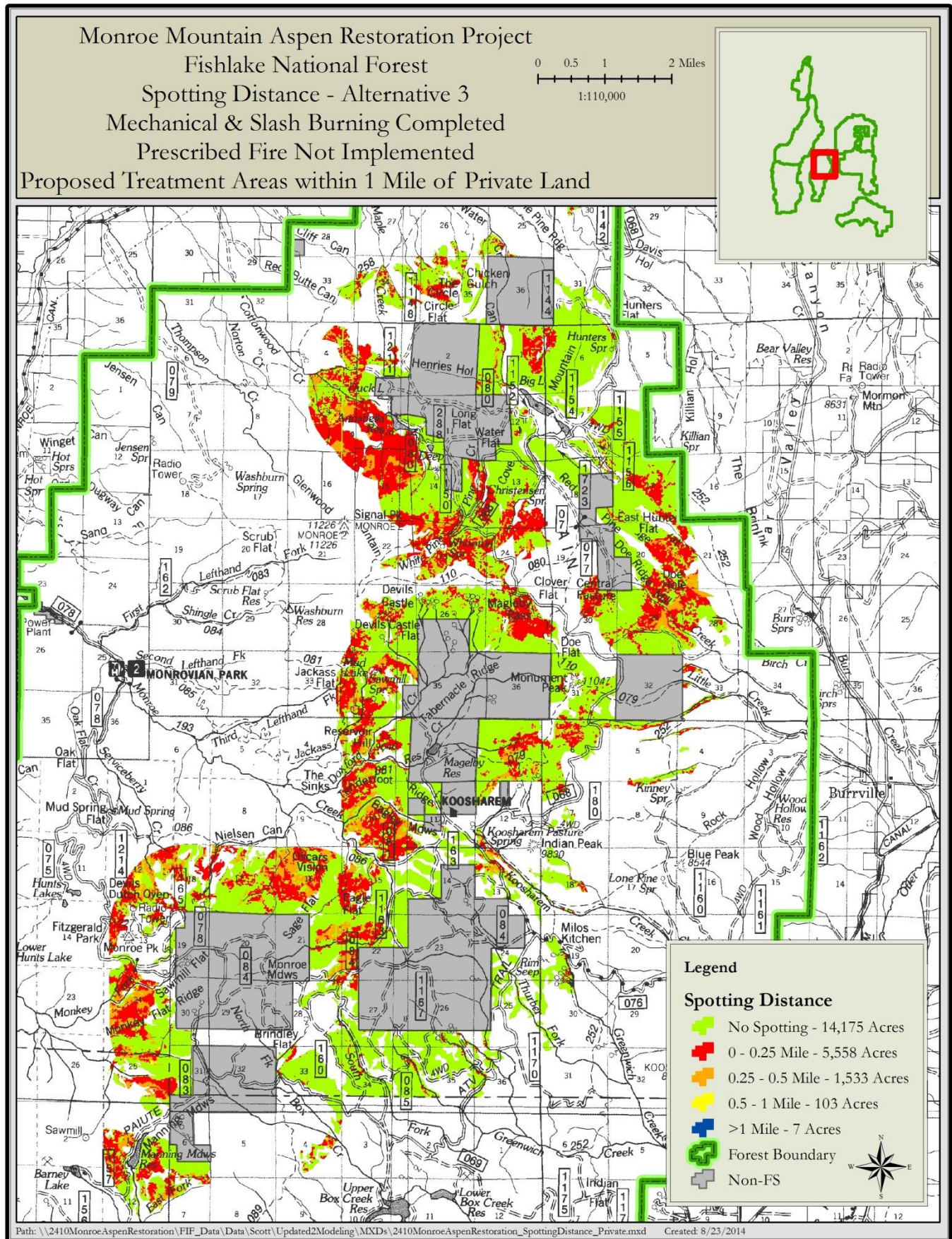
Map S - 2: Alternative 1 – No Action. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.



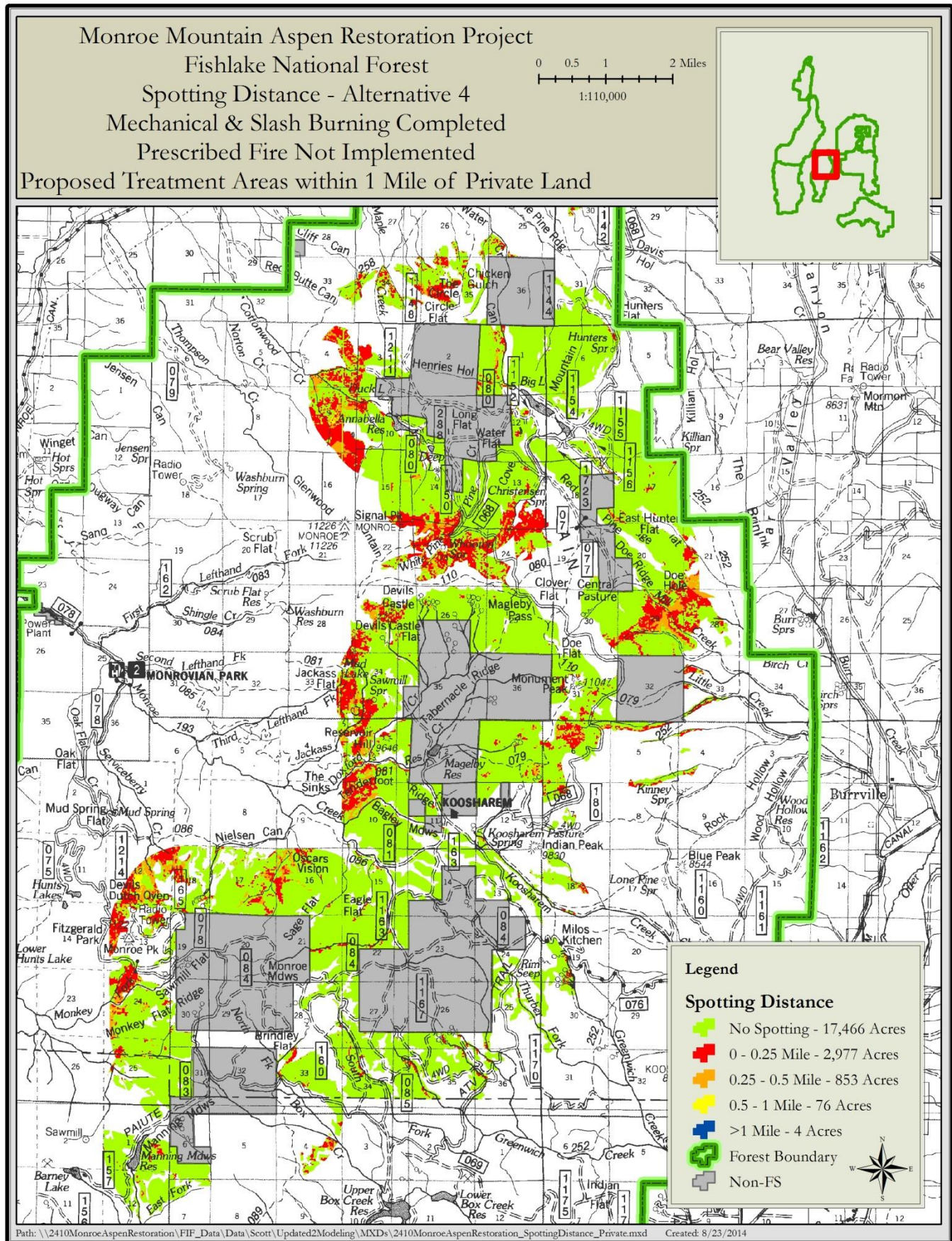
Map S - 3: Alternative 2. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.



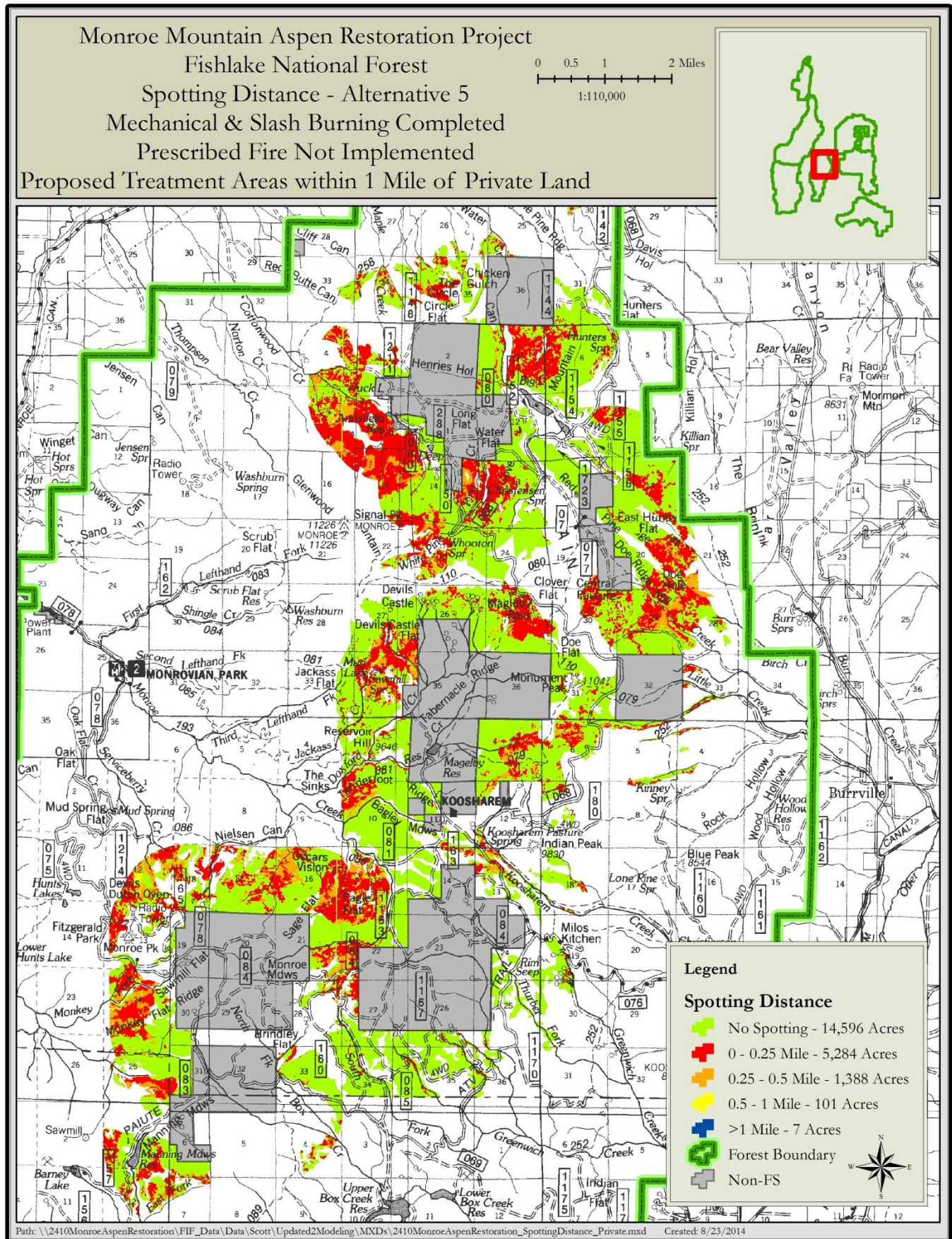
Map S - 4: Alternative 3. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.



Map S - 5: Alternative 4. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.



Map S - 6: Alternative 5. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.

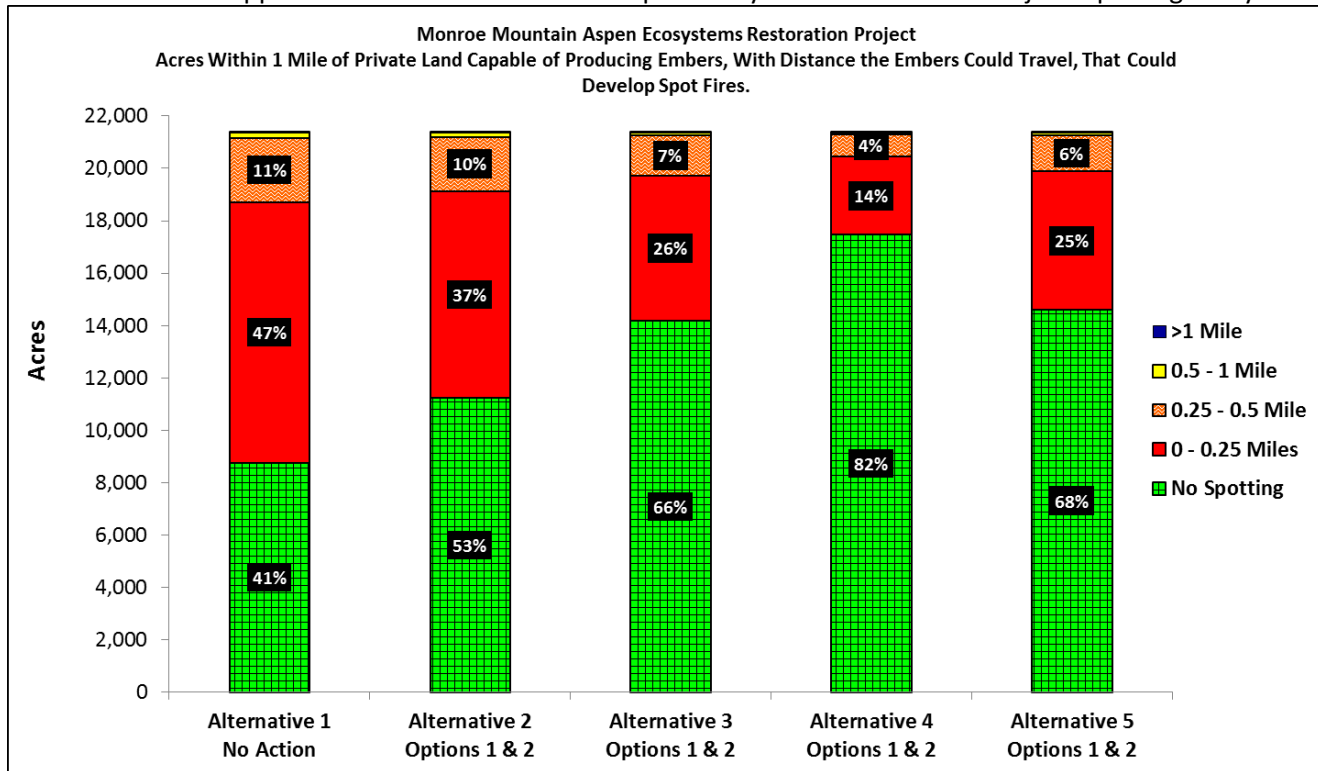


Figure S - 1: Summary of Alternatives 1-5. Acres within 1 mile of private land capable of producing embers, with distance the embers could travel, that could develop spot fires. Mechanical and slash burning (Options 1 & 2) completed and prescribed fire not implemented.

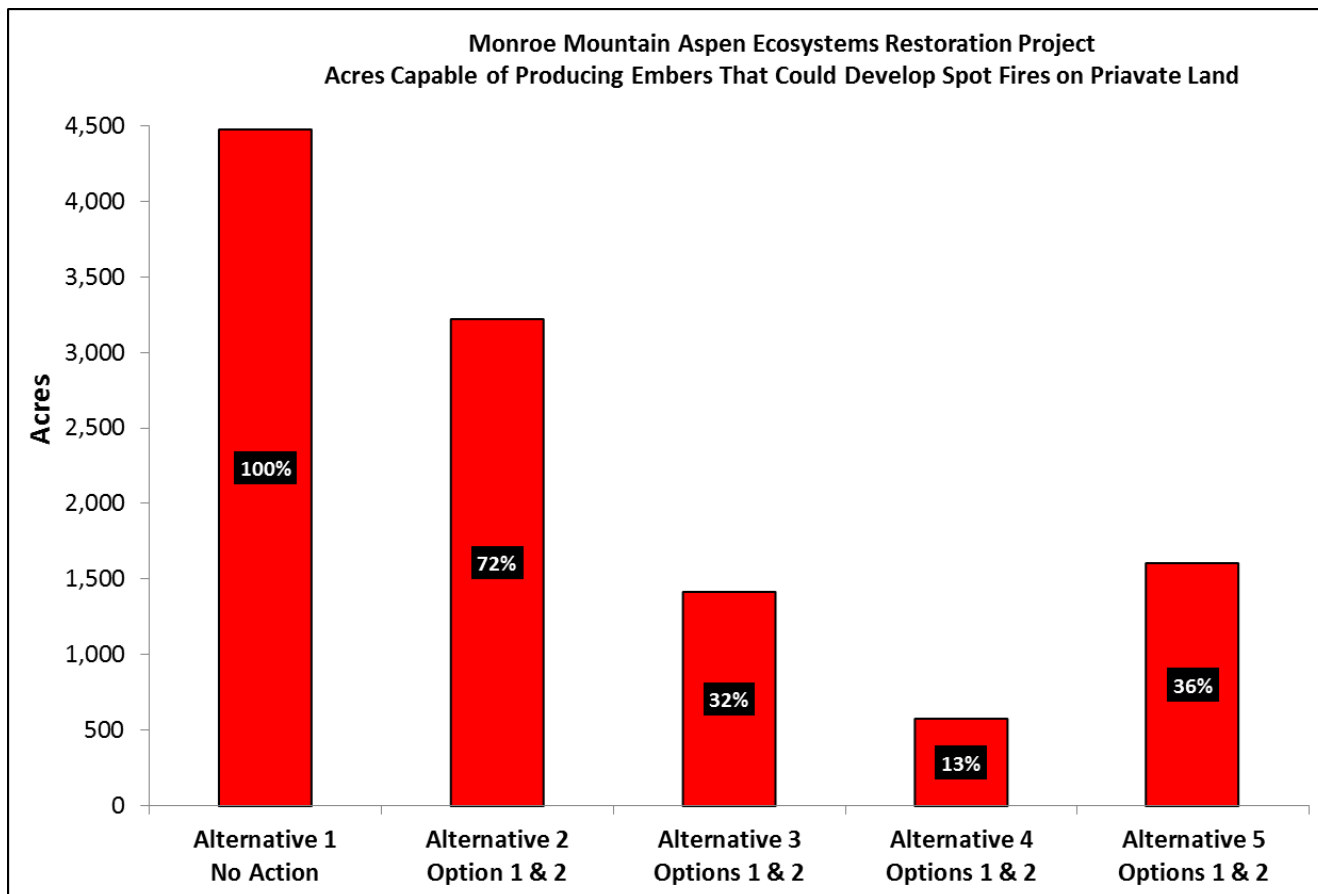
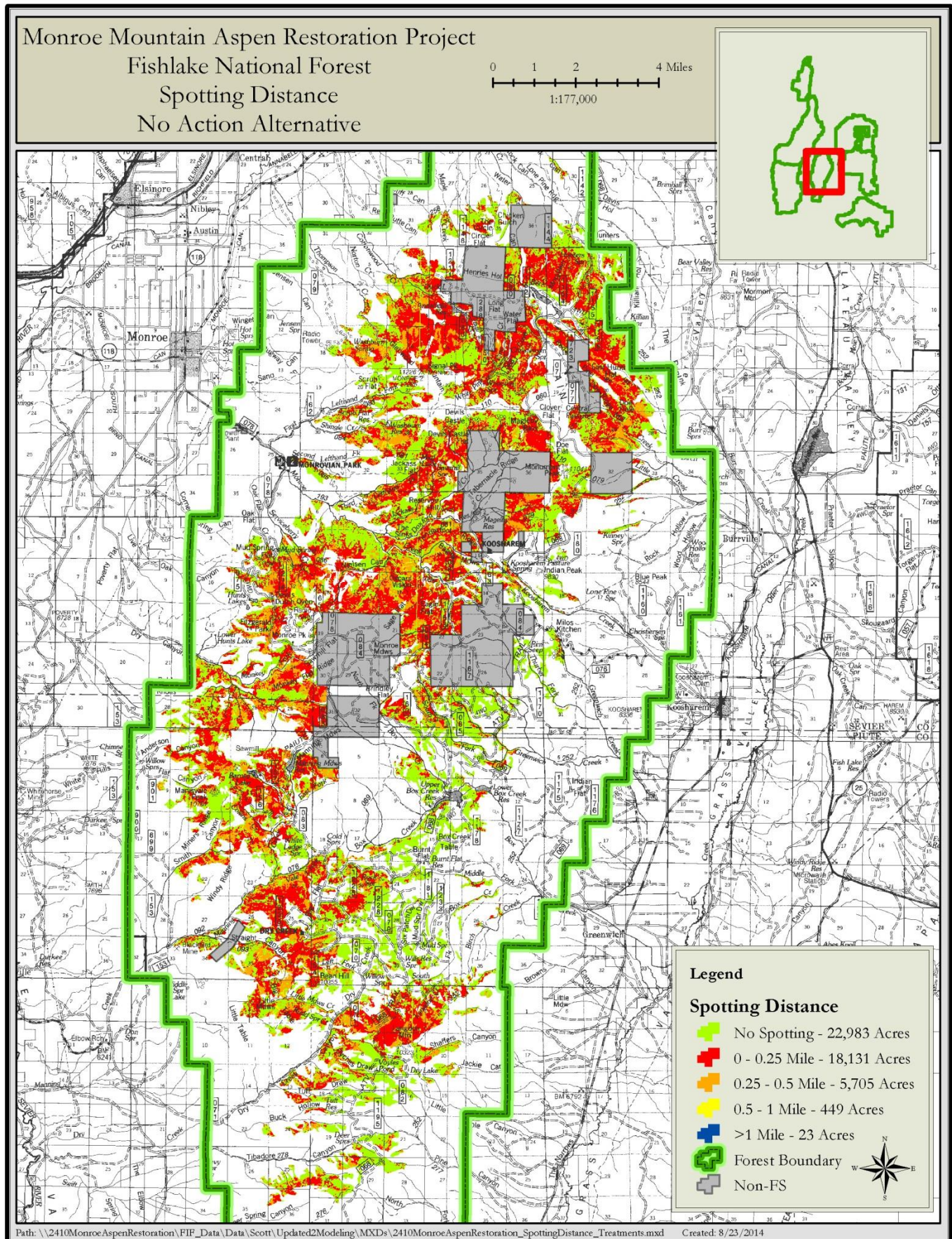


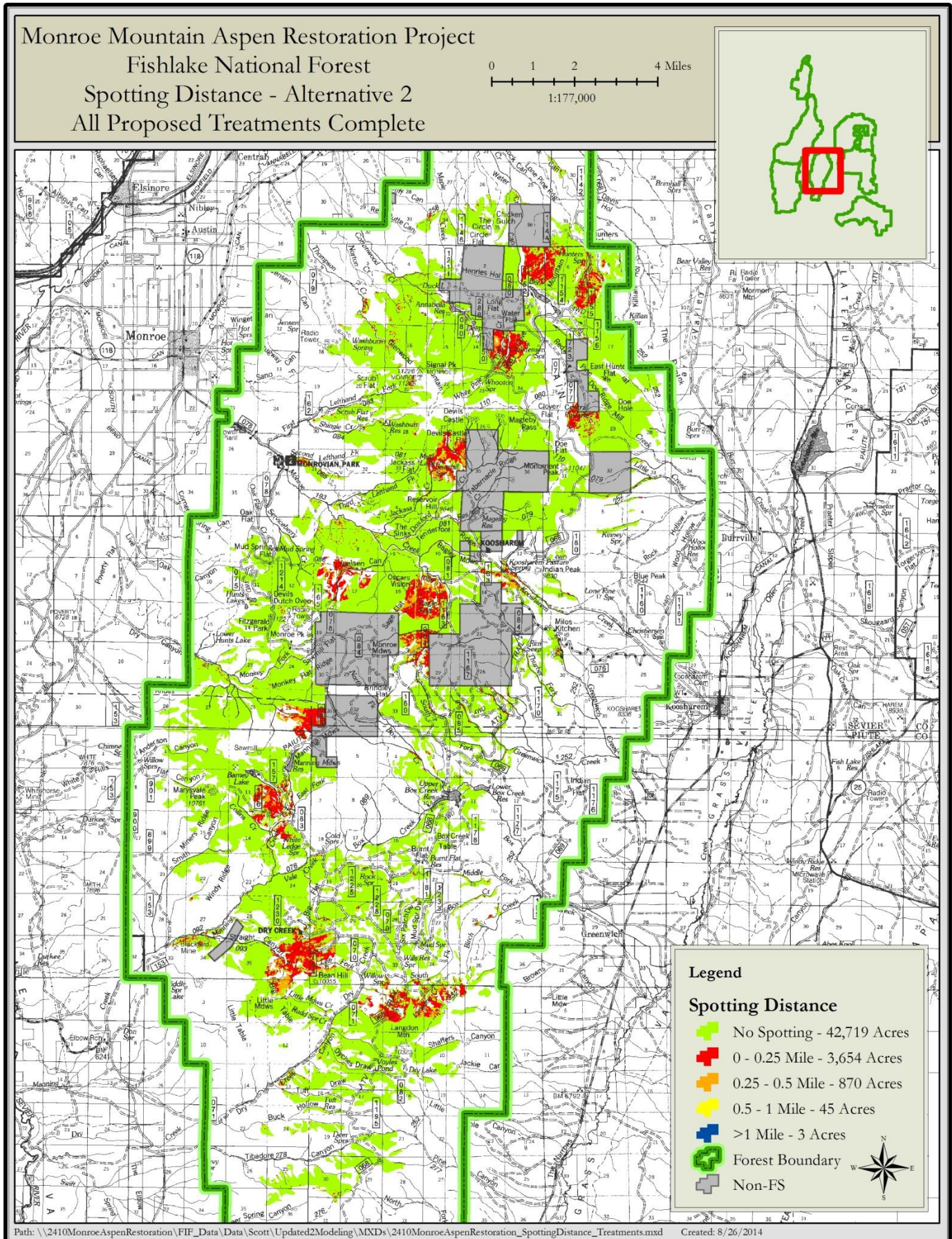
Figure S - 2: Summary of Alternatives 1-5. Acres capable of producing embers that could develop spot fires on private land. Mechanical and slash burning completed (Options 1 & 2) and prescribed fire not implemented.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.



Map S - 7: Alternative 1 – No Action. Acres capable of producing embers, with distance the embers could travel, that could develop spot fires.

Appendix S – Monroe Mountain Aspen Ecosystems Restoration Project. Spotting Analysis.



Map S - 8: Alternative 2. After all proposed mechanical & slash burning (Options 1 & 2) and prescribed fire treatments are completed, acres capable of producing embers, with distance the embers could travel, that could develop spot fires.